DEVELOPMENT OF A LOGISTICS
DAYS OF SUPPLY
REPORT GENERATOR

THESIS

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AFIT/GLM/LSM/90S-15



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# DEVELOPMENT OF A LOGISTICS DAYS OF SUPPLY REPORT GENERATOR

THESIS

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# Preface

To date, there has been no definitive "days of supply" (DOS) model produced for use by the base level logistician. Currently, base level logistic planners and operators develop DOS estimates and reports using "best guess" methods, or by long, inconsistent, manual calculations.

The proposed model and implementing report generator was designed to fill this need, and serve as a beginning for later efforts in logistic capability forecasting. To produce the DOS model and report generator of this thesis, I have had a great deal of assistance and encouragement. First, I am highly indebted to Colonels Lloyd Muller and Richard Stamler of Sixteenth Air Force, for providing the inspiration for this thesis. Secondly, I'd like to thank them both for their continued encouragement, time, and funding for this project. I would also like to thank Lt Col Richard Ferraioli and Captain Allen Ralston for providing data required for the computer databases. Major Phillip Beard also deserves a heartfelt thanks for getting me through the programming portion of this thesis. Finally, I'd like to thank my loyal and devoted thesis advisor, LT Donald McNeeley (USN), for his patience and courage to take this thesis topic on.

Cheryl A. Duckett

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## Abstract

The purpose of this thesis was to develop a model depicting a "days of supply" (DOS) and implement it through a computer program (LOGDOS) meaningful to both operations and logistics personnel for command post exercises or wartime use. LOGDOS was specifically designed for Air Force units having a flying mission. However, the model could be utilized in other units, after identifying a meaningful "measure of merit."

Following a literature review, a model was developed and implemented using dBASE III+™, R&R Report Writer™, and Clipper™. The developed program, LOGDOS, was then pre-tested, tested, and validated. The program meets the sponsors needs, and includes many improvements suggested by the sponsor unit during testing and validation of the program.

LOGDOS is easy to install, easy to use, and does not require user knowledge of any of the software development tools (such as dBASE III+™ or Clipper™). LOGDOS operates on a IBM-compatible microcomputer with 640K RAM, one hard drive disk drive, one 5.25 floppy disk drive, a monitor (monochrome or color), and an 80-column printer capable of continuous form paper.

# DEVELOPMENT OF A LOGISTICS DAYS OF SUPPLY REPORT GENERATOR

## I. Introduction

### Background

Commanders at all levels need to know what warfighting supplies they have, in what quantities, and the location of those supplies. This critical knowledge is as important in the command post exercise arena, as in real-world contingencies. However, this knowledge by itself is not enough; to be of use, it must be capable of forecasting future warfighting sustainability in a manner which increases mission effectiveness (33).

Currently, command post exercise participants either avoid such complicated forecasts, or attempt to produce them using pencil, paper, and hand held calculators. While this method is technically feasible, forecast accuracy and usefulness is doubtful. Two factors must be present to obtain usable results: 1) trained, knowledgeable personnel, and 2) adequate personnel resources to devote to this detail. In these days of reduced manpower and funding, the number of highly trained personnel is likely to fall. The number of command post exercises, on the other hand, will undoubtedly rise in an effort to substitute less expensive

(command post) exercises for the more expensive (live) exercises (25). Command post exercises give commanders (at all levels) practice in decision making applicable to wartime scenarios. However, without an accurate method to forecast logistic capabilities, they are, and will continue to practice making irrelevant decisions in an unreal world, a world that fails to reflect wartime scenarios (33).

Further complicating the issue, is the manner and terminology with which warfighting capabilities are presented. In order for the information to be useful, it must be presented meaningfully to both operators and logistics personnel. "Information must be presented so as to be meaningful to both operators and loggies so that all efforts converge onto...max bombs on target" (25). In summary:

> ...it is recognized that combat performance depends critically in the availability of timely and relevant information,...For example, improved information has no effect on the maneuverability of a particular aircraft or the rate of fire of a particular gun; however, it can profoundly influence combat outcomes by changing the choice of missions for the aircraft or the aimpoint for the gun. (22:7)

The bottom line measure of the usefulness of a warfighting capability forecast is how well it assists in clearly identifying what is needed, where it is needed, and when it is needed.

The major purpose of this thesis, then is to enable both logistics and operations personnel to understand the variables involved in "days of supply" calculations and

how these variables interact. The secondary purpose is the offering of a quick and accurate method to produce a warfighting capability forecast.

## Definition of Terms

1. "Days of supply" - "Days of supply" is a warfighting capability measurement based on the type/number of aircraft flown, associated sortie rates, and consumption rate (for all consumables)--at a given time--and based on projected aircraft roles and sorties (35).

2. Operators - Operators refers to warplanners who are rated flying officers. Operations refers in this context to warplanning staff agencies, staffed by operators.

3. Loggie - A loggie is a shortened, basically slang term for Air Force logistics personnel and agencies. Air Force logistics personnel include the functional areas of logistics plans, maintenance, munitions, supply, and transportation.

## Statement of the Problem

There is no uniform, efficient, and accurate way of calculating a "days of supply" figure/report (that is meaningful to both operations and logistics) for command post exercises or wartime use.

## Investigative Questions

The problem was approached by the author through development of a working "days of supply" model and software production of a report generator.

The questions used during the model building investigative process included (but were not limited to), the following:

1. What is a "days of supply" calculation and what variables must be included?

2. What given, constant values must be included?

3. How are these given, constant values derived, and what goes into their formulation?

Following the model building process, a new set of investigative questions were addressed in development of the report generator software program:

1. What type of a software program will address the problem as stated?

2. What type of hardware should the report generator be written for?

3. What programming language and techniques should be used?

4. What information should be on the reports produced by the report generator?

## Scope

The investigative questions were addressed in three stages. First, an extensive search of the existing literature and knowledge of the field of study was accomplished. Secondly, a working model was developed using

the defined variables. Lastly, a report generator was developed using the working model, to test the model's validity for command post exercises.

## Limitations

The model and report generator have a number of limitations. Generally speaking, the model and report generator is only applicable to Air Force units having a flying mission. Secondly, the supportability picture produced for these units is a static snapshot. Should any changes in the input variables occur, the report generator must be rerun for a reassessment. Finally, the report generator is completely dependent on the quality of information put in and can not evaluate input for appropriateness.

Moving on to more specific limitations of the reports themselves, it is important to note that the report generator produces a "days of supply" for fuels (POL) and munitions only. While the logic utilized is applicable for other logistic areas, for the purposes of this study only these two areas were selected.

For POL, the report generator uses the amount of fuel on hand in its calculations with the exclusion of all other factors, such as equipment and personnel shortages.

For munitions, the report generator uses the whole round number. In other words, ammunition fully built up (or available for build up) is used in calculations. Rounds

missing necessary parts (not on station) are not available for use, or included in the munition on hand quantities. In addition, the report generator does not take into consideration substitution tables for ammunitions, nor does it account for partial expenditure of ammunition during missions, except through the daily update of ammunition levels.

## Assumptions

Three basic assumptions underlie the proposed thesis model as it has been constructed. First of all, the model assumes one can accurately represe reality or the environment with quantitative variables. Implicit in this assumption, is the second assumption that it is possible to determine what these variables are initially and assign numerical values to them. Finally, the model is presumed to be a representation of reality. This too, rests on another assumption, that the variables are correct and accurate.

## Chapter Summary

In this introductory chapter, seven topics were covered in preparation for the chapter to follow. A discussion on the background issues led off the chapter, followed by a definition of the terms needing immediate clarification. After a brief statement of the problem, the research project investigative questions were listed. Next, a look at the

scope of the thesis was given. Finally, in closing, the limitations and assumptions of the model and the report generator were considered.

# II. Review of Related Literature

## Introduction

This literature review assembles the knowledge base from which was developed a report generator capable of producing a "days of supply" (DOS) figure for logistics planners and operators. During the search of the related body of literature, a number of projects -- some completed, some still under development -- were found. For this literature review, projects were reviewed in terms of general theory, clarification of terms and model variables, and how each project used mathematics and software techniques.

## Desired Model

The environment in which this model is to operate is the rapidly changing logistics situation encountered in NATO driven command post exercises, reflecting actual wartime scenarios. The desired model must be a simple, accurate presentation of warfighting capability measured in days. In addition to simplicity and accuracy, the working model must operate rapidly and easily with minimal training. Finally, the warfighting capability figure must be measured in days to be useful in the NATO environment, due to the fact that NATO measures logistic sustainability in days (25; 33).

## Method of Organization

The discussion of the reviewed articles is to determine the best way to go about developing a model for the identified use. This discussion focuses on three topical categories: 1) Model development, selecting the modeling process, whether it be qualitative or quantitative; 2) Mathematical formula derivation, selecting the level and complexity of mathematics required; and 3) Software structure and development, deciding on the software requirement.

Each category includes discussion of the articles' recommended course of action or problem solving approach and concludes with a summary of applicability to the thesis model. Definitions for terms used are found in Appendix A.

Category One: Model Development. After identification of a problem and mapping out an overall plan, one begins development of a model (2:13). Developing a model is considered as much an art as a science, as the goal is not an exact replica of the system under study, but the essence of the real system. Since "models are simply representations of real-world systems" (4:65), the choice of model type for a situation is driven by the system structure. Therefore, classifying the model as either quantitative or qualitative is the first step in choosing a

model structure. In order to determine which type of model classification should be utilized for the DOS model, it was necessary to review models of both types.

Two predecessors of more recent models for assessing readiness, survivability, and sustainability were the Theater Simulation of Airbase Resources (TSAR) and the TSAR Inputs using Airbase Damage Assessment (TSARINA). Both are Monte Carlo simulation models of a quantitative nature, developed by the RAND Corporation in the 1970s. Both models are designed in such a way as to make changes difficult, and only for the highly experienced. Model input variables include number of aircraft, wartime taskings, probabilities associated with tasks, maintenance requirements, quantities of spare parts, personnel and tasks, levels of consumables (munitions, TRAP, and Civil Engineering building material), and quantities of equipment items. Together this information represents the complex interrelations of an airbase. The result of such modeling is aimed at a tactical support analysis in terms of the sortie generation capability (31:1,I-1).

As for the insight these offer to the desired model, TSAR and TSARINA are both quantitative models, use a number of important variables and are database driven. Although the modeling design of these two models lack flexibility, the models produce a quantitative measure of combat capability using quantitative variable manipulation. The

variables used to produce the combat capability measure include aircraft quantities, wartime taskings, and quantities of consumables on hand -- all quantifiable variables and of possible use in the DOS model. These models also demonstrated how important a database is in a model.

Davis discusses two qualitative models: the RAND Strategy Assessment System (RSAS) and the "National Command Level" (NCL) model. These two models are "...knowledge-based simulation(s) for analytic war gaming..." which Davis feels have some major problems (9:1). Davis considers the major problems to be the result of "...minimizing ambiguity when working with qualitative variables..." (9:5), and the development of a methodology for combining these variables. To overcome these problems he suggests:

1. define variables as they are introduced,
2. plan for shifts in variable meanings from one context to another,
3. minimize impact of qualitative variables,
4. restructure model rules in order to keep lowest-level variables out of the direct determination of highest level variables, and
5. aim to use aggregations of variables when one can not keep lowest-level variables out of the direct determination of highest-level variables (9:6).

The problems associated with qualitative models and variables appear to stem from the difficulties involved in assigning values to them. In the desired model, the output

is a quantitative DOS figure, as previously presented. The variables, as yet unidentified, may be qualitative and therefore difficult to assign qualitative values to, but the final model result must be quantitative in nature.

The problem of accounting for uncertainty in models must also be addressed during the development of a model. Historically, statistical analysis has been the means to handle uncertainty. Draper has proposed new ways to address this uncertainty and to ultimately derive an "aggregate measure of predictive uncertainty" (12:v). His methods include:

1. retrospective calibration techniques,
2. modification of Bayesian methods, allowing for model uncertainty, and
3. adaptation of summary Bayesian presentation methods (12:1-21).

Yet another model addressing uncertainty, is the Coupling Logistics to Operations to meet Uncertainties and the Threat (CLOUT). CLOUT's authors report that advances in analytic modeling can account for combat operation uncertainty. They believe that integrating both simulation and analytic methods in modeling is the way to create the necessary system approach. Aircraft availability assessments drive support actions throughout this model (30:1-12).

The initial model construction conclusion is that the desired model does not address the topic of uncertainty. The desired model must produce a quantitative DOS for planners, not assign some level of probability or certainty to the output. In the Rich model, simulation was used as a tool to handle uncertainty, and although the DOS model does not address uncertainty, using a simulation to foster a system approach to modeling is desirable. The model should be viewed as a part of the whole, not an un-integrated product, and using the model as part of a simulation will allow the necessary integration adjustments.

Probably one of the best known models built to support logistics capability assessments, is the Dyna-METRIC computer model. This model, developed by the RAND Corporation, is analytic in nature, and "...uses mathematical equations to forecast how logistics support processes would affect flying units' capability in a dynamic wartime environment" (28:vi,vii).

The data input for analysis consists of six major sections:

1. Administrative information - how the reports will look, the users' desired analysis

2. Operational and support scenario - includes the number of aircraft, sortie rate, flying hours per sortie, aircraft attrition rate, mission requirements, maximum sortie rate

3. Component description - details on each part's failure and repair operations

4. Subcomponent description - details on each part's failure and repair operations

5. Test-equipment - information on which/what quantities of test equipment is needed, test equipment characteristics (such as failure rates)

6. Stock quantities (28:40)

Dyna-METRIC provides the following types of information:

1. Operational performance measures,

2. Effects of wartime dynamics,

3. Effects of repair capacity and priority repair,

4. Problem detection and diagnosis, and

5. Assessments or requirements (28:vi).

In the latest version, Version 4, several new features were incorporated:

1. Inclusion of an additional level of components and echelon of component repair/supply,

2. Expanded ability to analyze multiple aircraft types,

3. More detail in the description of component pipelines, and

4. Expanded report capabilities (19:iii).

Another model, the Combat Support Capability Management System (CSCMS) incorporates the Dyna-METRIC model (18; 17), however it obtains different results. The

> CSCMS was designed to serve two purposes. First, it is a capability assessment system that forecasts the logistics system's readiness to support wartime activities. Second, it is a management information system designed to track logistics performance measures and indicate when and where corrective action may be necessary...(29:5)

The prototype model consisted of two subsystems and used three variables in its assessments:

1. Authorized (planned) resources on hand,
2. Logistics system performance characteristics (such as demand rates and repair cycle time), and
3. War scenarios (such as flying taskings)(29:2).

From these interrelated variables, the model produces three measures of wartime capability (for each base): available sorties, expected Not Fully Mission Capable (NFMC) aircraft, and the probability of the base holding the NFMC at or below a user specified target level (29:9).

Dyna-METRIC and its spin-offs are highly complex models, with numerous input variables and output products. The DOS model, on the other hand, produces only one figure, and the input is limited to the variables required to produce this single figure. But for all its complexity, Dyna-METRIC still is a quantitative model, and produces a operational capability assessment based on quantifiable variables. Although the desired model must produce a DOS, this is essentially a capability assessment in another format. The key variables used by Dyna-METRIC are number of aircraft, sorties rate, flying hours per sortie, mission requirements, and stock quantities -- all quantifiable variables and of possible use in the DOS model.

Another model for the total logistics support process also exists (20). Jones' model is simplistic, with an easily built database (user built) and runs on commonly available Zenith and IBM compatible microcomputers. The resulting program entitled Expected Value-based Logistics Capability Assessment Model (ELCAM) is an analytical model.

The key variables used in his model include:

1. Number and Type of Aircraft,
2. Planned Sortie Rates,
3. Mission Types or Roles Flown,
4. Sortie Length,
5. Length of Conflict,
6. Frequency of Mission Types,
7. Day of the War,
8. Planned sortie rates and lengths for individual roles for a specific day of the war, calculated in days,
9. Attrition Rate,
10. Battle damage rate for mission type,
11. Mean time to repair battle damage for mission type,
12. Time required to refuel an aircraft for mission type,
13. Time required to re-arm an aircraft for mission type,
14. Number of aircraft needed to start mission type,
15. Number of aircraft needed to finish mission type,
16. Number of hours in a day that maintenance is performed,
17. Numbers of spares and critical resources on hand,
18. Supply pipeline time required,
19. Percent base repair for part(s), and
20. Percent of parts condemned (20:10).

Using this extensive list of model variables, Jones' model provides wing-level managers key decision making information identifying system shortfalls and potential resource bottlenecks.

For the purposes of the desired model, Jones' model has several applicable items. Although the Jones model does not produce a combat capability figure per se, it uses the same key variables as other combat capability measurement models. These variables are number of aircraft, sorties rate, flying hours per sortie, mission requirements, and stock quantities -- all quantifiable variables and of possible use in the DOS model. Lastly, the Jones model is a simple model which utilizes a user built database.

From review of the literature at this point, it appears that a developed DOS model can be a simple, quantitative model which uses a common set of key quantitative variables (aircraft quantities, sortie rate, flying hours per sortie, mission requirements, stock quantities) to produce a combat capability figure in days.

The Future. The future and importance of combat assessment models has recently been recognized officially. The requirement for developing sustainability models for capability assessment was made a part of official Department of Defense policy in 1987. The Defense Resources Board (DRB) through the 1990 - 1994 Defense Guidance directed the Services to develop operationally-oriented measures of sustainability. These new measures or models are to be used to assess the 1992 - 1996 Program Objective Memorandums (POMs) for munitions, secondary items, fuel, and replacement end items (27:Executive Summary).

The goal of the DRB is to develop a uniform measure or model of sustainability applicable across all the services. The current "days of supply" figures derived by each Service were felt to be too ambiguous and inadequate to provide meaningful, useful assessments of wartime military capability (27:1). Even though this is the format in which NATO measures combat sustainability, there should be a better way to determine logistics warfighting capability (16). In the DRB tasking memorandum the following guidelines for the effort are outlined:

1. The analysis should be based on the Defense Guidance Illustrative Planning Scenario. This guidance document provides the assumptions about warning reaction times and probable scenario activities.

2. The goal is to develop consistent, threat orientated measures-of-merit across Services.

3. The relevant factors or variables such as attrition and cannibalization, should be uniform across the services.

4. The measure or model developed by each Service must be easily related to the duration of combat sustained. For example, flying units would use number of sorties as a basis for quantifying duration of combat (27:1-5).

With this tasking in mind, this discussion continues with a look at the modeling efforts of each service.

Army. The Army does not break down its requirements according to specific warfare mission functions. Nor does it measure combat durations in independent, discrete sorties. Instead the Army determines its materiel requirements based on the organizational structure of its combat forces. The Army expresses this in terms of "days of supply" on hand for the combination of weapons systems called for in a specific theater of operation (27:7).

Navy. The self-sufficiency concept of Navy employment doctrine drives Naval logistics support. In line with this concept, the Navy proposes the use of several measures to reflect the type of platform (air, surface, and sub-surface) and the mission tasking (anti-submarine or air warfare). Aviation sustainability assessments will use the on hand component inventory, sortie profile data (includes aircraft attrition rates, sortie rates, aircraft carrier deckload, aircraft inventory by type, maintenance capability, weather takeoff adjustment factors, and carrier deployment schedule) in an analytic model to provide estimates of available sorties, and sortie rates (27:12).

Coming up with a model for the rest of the fleet, is not so straightforward. For the rest of the shipboard weapon systems, the concept of "operational availability" measures combat readiness and sustainability. "Operational

availability is defined as the probability that a weapon system/equipment will perform as designed when it is required" (27:12). This measure will be taken for each primary warfare mission area on board ship, and also aggregated to the ship level. The tool to do this assessment will be the Design Reference Mission (DRM), presumedly a model, that is tailored for each class of ship in the fleet. The DRM takes the expected wartime usage, mission duration, wartime maintenance and support policies, and provides the warmaking capability assessment of the ship. The DRM is also supposed to allow what-if analysis in changing operations or logistics support (27:13).

Marine Corps. Marine Corps forces are sized according to mission requirements and consist of an integrated package of ground, aviation, and combat service support elements. Material requirements are computed to initially outfit the force, plus attrition replacements. Requirement computations are based on the unit composition of each employed force and the mission specific requirements. The Marine Corps aggregates these requirements by thirty day increments for each force size. Combat sustainability is expressed in the aggregate average daily rate of usage, or "days of supply" available. This is the presently used method. The Marine Corps, due to its

commonalty with the other services, plans to closely monitor and adapt/adopt the applicable modeling efforts of the other services (27:14-15).

Air Force. The Air Force (of the four Services) has done the most work toward model development of operationally oriented measures of readiness and sustainability. Sustainability for key weapon systems is based on reparable aircraft spares, munitions, and fuel, and the expected wartime operating activity (27:16). The Air Force has four major sustainability capability assessment modeling efforts underway: the Combat Ammunition System (CAS), the Enhanced SORTS Capability Assessment Model (ESCAM), the Logistics Capability Measurement System (LCMS), and the Weapons System Management Information System (WSMIS).

The Combat Ammunition System (CAS) is an inventory management tool, designed to enable component commands to respond to requirements from operational commanders, as well as control the flow of munitions from wholesale to retail sites.

CAS computes munitions requirements to support sortie requirements, selecting the best munition mix for the mission (based on the most kills-per-dollar as a measure of merit).

ESCAM is an analytic model built on the RAND Corporation Theater Simulation of Airbase Resources (TSAR). ESCAM is intended to measure warfighting capability at the unit/theater/Air Force level, and determine the contribution of the logistic resources toward the unit's ability to carry out its mission. "These unit assessments consider operations tempo and will provide ... measurements in terms of sortie generation rates, flying hours, and aircraft availability" (27:21).

The LCMS is a group of models designed to provide information and justification data for decision making in the Federal Planning, Programming, and Budgeting System process. Six of the models were listed: Aircraft Availability Model (AAM), Aviation Fuels Capability Assessment Model (AFCAM), Aircraft Sustainability Model (ASM), Munition Assessment Model (MAM), and the Spares Wartime Assessment Procedure (SWAP). As a group, the LCMS assesses logistic capability to meet assigned peacetime and wartime missions, using analytic modeling techniques. The LCMS assesses changes in flying hours, funding levels or inventory, and evaluates strategies for resource allocation (27:21).

The WSMIS is an automated modeling tool and management information system designed to assess current unit/theater/Air Force ability to sustain the warplan required sortie levels, with on hand assets. WSMIS was

developed in conjunction with RAND Corporation, and is based upon the Dyna-METRIC model. The input variables include tasked airframes, forecasted maintenance factors, planned aircraft use rates (sortie rates per day), number(s) of on hand aircraft spares, sortie durations, and forecasted rates for aircraft availability (based on wartime attrition rates) (34; 27:17). Planned model enhancements include associated factors for consumable items such as fuel and munitions. Using this information, WSMIS provides commanders at all levels with assessments on unit ability to generate combat sorties, or wartime flying hours, in accordance with warplan taskings (27:17).

WSMIS has four modules: Readiness Assessment Module (RAM), Sustainability Assessment Module (SAM), Get Well Assessment Module (GWAM), and Requirements/Execution Analysis Logistics Module (REALM) (32). RAM and SAM are the combat assessment modules of the system. But WSMIS is also designed to help improve combat capabilities through a module called GWAM, once problem areas are identified. The final module, REALM, is designed to determine minimum asset requirements to meet wartime aircraft sorties and achieve maximum readiness within budgetary constraints (27:20).

In summary, a set of key variables and a common model structure emerge form the literature reviewed. However, not all of the articles have direct application. Although interesting from a historical perspective, TSAR and TSARINA,

have little direct application to the desired model. Although using the database modeling design makes changes difficult, the variables used in the effort are much the same as for other combat sustainability models, and appear key to any quantitative combat capability assessment.

Considering the Davis approach, for the purpose of this model, his approach does not directly apply. The major thrust of Davis' work was aimed at the ambiguity of qualitative models, and since the proposed model is quantitative in nature, Davis' approach was not applicable.

Draper's primary concerns in his model building approach were predictions and the control of uncertainty. Neither predicting outcomes nor controlling uncertainty is a part of this model's purpose. Therefore, Draper's insights are of limited use.

Rich's approach to modeling and model building has direct application to the desired model. His first step included building the model as a part of the system. Then, Rich conducted a simulation--to both test his model and forecast future system capability. This problem solving method is a systems approach as opposed to an incremental or selective method.

RAND Corporation's Dyna-METRIC is an analytic, mathematical model representing the logistics environment and its relationship to the flying units' capability in the ever changing environment of war. The scope and complexity

of this model is far beyond the scope of the proposed model, however, there are two items of noteworthy application. First of all, Dyna-METRIC uses a purely mathematical approach to model building, and uses it successfully. Second, a number of the key input variables have application. Of particular note are the operational and support scenario variables (number of aircraft, sortie rate, flying hours per sortie, mission requirements) and of course, stock quantities. Dyna-METRIC uses these key variables to produce a measure of operational performance, as do many of the models studied.

Pyles and Trip's model is a Dyna-METRIC driven, dual module system designed to plan and control component repair and spare parts support. One module calculates the resource and performance required to meet the mission requirements; the other module tracks and identifies logistics support shortfalls. This model attempts to predict potential logistics problems, the scope of which this thesis is not addressing. However, the three variables used in the model are the basic building blocks from which a capability assessment is made, and have direct application for the model in this thesis.

Jones' approach was also applicable to the proposed thesis model. Not only are some of the same model variables useful for this thesis, but the methodology used was

applicable as well. Jones uses a database approach to produce a small, simple, fast, and reasonably accurate program which represents an analytical model (20:2).

The DRB's requirement for the Services to develop sustainability models has produced some interesting and useful developments for future study. Although the Services are still quite a ways from a uniform measure of sustainability, several things are of note across Services. First of all, all four Services have used analytic "days of supply " measures or models, and two Services still do. Lastly, the aviation branches of all the services use the same key variables (sortie rates, attrition, assets on hand -- to name a few) to produce a capability assessment.

Category Two: Mathematical Formula Derivation. From the previous discussion, it was found that the proposed model should be quantitative in nature. Therefore, "Analytical or mathematical models require the model builder to write mathematical equations depicting exactly how the input to the model are to be transformed into output" (4:65). This works when one can determine what the equations should be, and the equations accurately reflect the system modeled. Many models are not this simple. The next section reviews a selection of mathematical modeling techniques ranging from the easy-to-pin-down, to the not-so-easy.

Looking again at the Davis qualitative models, he considered translating his qualitative variable models into algebraic expressions. He subsequently ruled out this approach as unsuited to represent the logic of a qualitative knowledge-based model (9) and suggested the following:

1. Make a table of combination-rules, such as simple averaging (Good + Bad = Mixed) and/or rounding-up averaging (Good + Mixed = Good) that apply to the model,

2. Carefully define each combination-rule, and

3. Formalize the rules in terms of algebra or a programming language (9:9-14).

Since the desired model is quantitative, use of this information is not applicable.

In the Draper model, retrospective calibration techniques were used to handle model uncertainty. These techniques were developed by modifying Bayesian methods to allow for the model uncertainty, and finally by adapting Bayesian presentation methods (in summarized format) (12). The topic of uncertainty does not enter into the model construction, as the desired model is only required to produce a quantitative DOS for planners, not assign some level of probability or certainty to the output. Therefore Draper's approach is of limited use.

Regression analysis is another mathematical modeling technique. Duan and Li used regression to produce a prediction or forecasting model. First, they studied the relationship between outcome variable "y" and the regressor

variable "x" (following the mathematical transformation of "y") after they completed a regression on the variables. Then, Duan interpreted how well the regression results predict the outcome of a given scenario (13).

Predicting outcomes is not a function of the model under construction, and as the Duan and Li methodology is aimed at prediction, this approach is not usable.

Dyna-METRIC and its clones, all are founded on analytic modeling of the systems they represent. The basic model computes expected pipeline contents and their probability distributions. Once the appropriate probability distributions are determined for the various system subcomponents, these distributions are used to predict performance and recommend stock levels. This manipulation of probabilities is beyond the simple quantitative DOS model proposed, and although informative, not directly applicable.

Jones specified a set of variables (such as sortie rates, mission types, sortie length, length of conflict, and number of aircraft) which affect the probability of mission completion/weapon system reliability (20). Then, he combined the expected downtimes associated with these variables and divided the result by the total flying hours. This mathematical process calculates the probability that the aircraft "get into the air and perform the mission" (20:8). As a model which produces a probability index, the math involved is not directly applicable to the DOS model.

In summarizing category two, Davis' coverage of the mathematics of qualitative variable modeling was reviewed for applicability. As the proposed thesis model does not make use of qualitative variables, the Davis approach was not considered directly useful.

Draper's modeling approach was also of limited use, since structural uncertainty was not included in the model developed by this thesis. Duan's mathematical manipulations are of little use as well, since predicting outcomes was not a function of the thesis model, either.

The Dyna-METRIC approach uses a level of mathematics not required for the thesis model. The calculation and use of probabilities through calculus and statistics is beyond the scope and requirements of the simplified "days of supply" model under development.

Although the goal of the Jones model/program was not the same as that of the proposed model, his model variables are of interest and application for the proposed model. Also of note, is the simple nature of his model calculations, a directly applicable and desirable characteristic for use in the proposed thesis model.

It would appear from the information available, simple and quantifiable are the key words in development of the mathematical properties of the DOS model. Additionally, the literature review did not revealed an available model reflective of the desired model.

Category Three: Software Structure and Development. Following model building, and data collection the actual coding or development of the implementing software takes place (2:14). The remainder of this chapter is devoted to reviewing similar programs to that of the proposed model.

Many methods exist for implementation of a model. One of the simplest and most quickly implemented was a Decision Support System (DSS) developed by Captain Akong, using ENABLE (1). The DSS was designed for Zenith and IBM compatible microcomputers to track assets in a theater of operations. The program/DSS allowed the manager to quickly determine asset levels and availability should redistribution of assets in theater be desirable, but not to produce a sustainment capability measurement. The database included all War Consumables Distribution Objective line items, and a brief list of the most theater critical items.

The strong points of Capt Akong's DSS were its use of available software for commonly available hardware and its ability to quickly assess regional asset levels through use of a user input database.

Jones developed the ELCAM program for Zenith and IBM compatible microcomputers and provides a User's Guide and a Flow Chart of the program itself (20). The program's estimating accuracy tested well when compared to larger models and to real-world exercise results.

Here again, the programmers used commonly available hardware and a user input database. Both of these features deserve consideration in the DOS programming process.

Lynch developed the AFCAMS program for Zenith and IBM compatible microcomputers with a spreadsheet installed (LOTUS or VP-Planner only) (23). The program is spreadsheet based and produces a fuels logistics capability assessment for planners.

The program has five modules addressing different aspects of the generic base fuels system:

1. fuel dispensing capability,
2. fuel receiving capability,
3. fuel inventory,
4. refueling turn around time, and
5. fuels manpower (23:1-6).

AFCAMS has little to provide to the DOS programming project. By using a spreadsheet, one compels the user to purchase and be literate of the spreadsheet. In this case, the spreadsheet used is not an Air Force standard, although the hardware is.

The WSMIS system is a complex program written in FORTRAN for mainframe use. WSMIS is designed to assess current unit/theater/Air Force ability to sustain the warplan required sortie levels, with on hand assets. WSMIS was developed in conjunction with RAND Corporation, and is based upon the Dyna-METRIC model.

WSMIS consists of four modules: Readiness Assessment Module (RAM), Sustainability Assessment Module (SAM), Get Well Assessment Module (GWAM), and Requirements/Execution Analysis Logistics Module (REALM) (32). RAM and SAM conduct combat assessment for the system. But WSMIS is also designed to help improve combat capabilities (upon diagnosis of a problem), through a module called GWAM. The last module, REALM, determines minimum asset requirements to meet wartime aircraft sorties and achieve maximum readiness within budgetary constraints (27:20). WSMIS is a highly complicated program capable of forecasting future capabilities, which is puts it in a different category than the simple DOS program under development. WSMIS also requires a mainframe, whereas the DOS program with its less demanding programming requirements should not.

To summarize category three, Captain Akong's program offers some guidance. His program made use of available software; commonly available hardware and addressed a problem directly and effectively with little frill. As previously discussed, Jones' program has direct impact on the desired model, both in the selection of variables, and programming methodology. On the other hand, AFCAMS has limited if any applicability to this thesis. As for WSMIS, the complexity of this program and its hardware requirements

make parallels difficult to draw. However, WSMIS's selection of parameters and variables assure their incorporation into the proposed model.

Charter Summary

In summary, a variety of articles were reviewed for input and information for the research topic. The articles fall into three categories:

1. Information on Model development,
2. Mathematical formula derivation, and
3. Software structure and development.

Category one used eight sources and their views on model building. Category two compared five viewpoints on the development and use of model mathematics, and category three covered the four sources having computer programs available for review. Based on the literature review several model approaches have direct application. First, a database approach to the model execution was suggested for executable models that are small and simple. Secondly, certain variables surfaced as important in the course of the literature review, and lastly, simulations were suggested as part of the integrated system approach to model building.

Finally, it appears that the desired thesis model or a similar one, and its variables have never been fully articulated, and a fully operational program or report generator has not been implemented in the field.

## III. Model Development Procedures

### Introduction

The method of this thesis is divided into four steps: Following a search of the existing literature, the applicable variables were identified, defined and used to formulate the proposed DOS model. Next, the model was used to write the report generator computer program. The report generator was then pre-tested and finally taken to the field for a simulation test.

### Development of a "Days of Supply" Model

To derive the model the variables were first determined, researched and defined. The next step was actually deriving the model, relating the variables and the given, constant values in a meaningful and appropriate manner.

The Model. The "days of supply" model is a measurement of future warfighting capability which is driven by the type and number of aircraft flown (35). Once one knows the type and number of aircraft involved in the computations, several associated questions arise. First, one needs to know the associated sortie rates and duration of a single sortie for the projected aircraft roles. Secondly, the consumption rates per mission or per hour of flight time must be known or calculated.

The overall DOS model formula is as follows:

$$DOS = \frac{C}{(EPM)(A)(S)} \qquad (1)$$

where

| | |
|---|---|
| C | Amount of consumable on hand |
| S | Sortie Rate |
| A | Number of mission capable aircraft of one type, all flying a specific role |
| CR | Consumption rate of a consumable per hour for specified aircraft in specified role |
| ML | Length of mission in specified role |
| EPM | Expenditure per mission = (CR)(ML) |

(14)

Since the fuel and munitions calculations are different, an example of each follows:

$$\text{FUELS DOS} = \frac{C}{(EPM)(A)(S)} = \frac{30000000}{652800} = 4.595588 \qquad (2)$$

where

| | | Test Numbers |
|---|---|---|
| C | Amount of consumable on hand, like gallons of fuel (consistent measure). | 30000000 |
| S | Sortie Rate, "Given" for a specific role. | 3.4 |
| A | Number of mission capable aircraft of one type, all flying a specific role. | 16 |
| CR | Consumption rate of a consumable per hour for specified aircraft in specified role. | 8000 |
| ML | Length of mission in specified role. | 1.5 |
| EPM | Expenditure per mission = (CR)(ML) | 12000 |

$$\text{AIM 9 MUNITIONS DOS} = \frac{C}{(EPM)(A)(S)} = \frac{150}{16} = 9.375 \qquad (3)$$

| where | | Test Numbers |
|---|---|---|
| C | Amount of consumable on hand, like number of Aim 9 missiles. | 150 |
| S | Sortie Rate, "Given" for a specific role. | 3.4 |
| A | Number of mission capable aircraft of one type, all flying a specific role. | 16 |
| CR | Consumption rate of a consumable per mission for specified aircraft in specified role. | 1 |
| ML | Not applicable for munitions. | 1 |
| EPM | Expenditure per mission = (CR)(ML) | 1 |

Variables Included in the Model. The key variables in this model are consumable, sortie rate, aircraft, consumption rate, mission length, and expenditure per mission.

Consumable (C). The consumables in this model refer to either munitions or fuels. For munitions, this variable is a whole round number of the exact number of on hand munitions. For fuels, this variable is the gallons of fuel on hand, usually rounded off to the nearest thousand gallons. The model uses the letter "C" to denote the amount of the consumable.

Sortie Rate (S). A sortie rate is aircraft specific with the rate established for all types of aircraft depending on mission use. For example, a fighter aircraft's sortie rate for an air-to-air mission might be 3.4. At a 3.4 sortie rate, the fighter flies 3.4 times per flying day.

Sortie rates are specified in the War Mobilization Plan (WMP) IV and V, and are driven by the "perceived threat" determined by intelligence sources and the overall planned strategy to meet this threat with the available resources.

The model uses "S" to denote the sortie rate in the model.

<u>Aircraft (A)</u>. The model uses "A" to represent the number of aircraft of a specific type, that are projected to fly in a specified role and time period.

<u>Consumption Rate (CR)</u>. The consumption rate of a consumable in the context of this model is broken into two parts. First, to be considered is the consumption rate for munitions and how it is calculated. The last part of the definition is concerned with the calculation of the fuel or POL consumption rate.

The consumption rate for munitions is established by each command. At the HQ USAF level, a basic consumption rate is established. Each command then modifies it for their own unique and specific purposes. This consumption rate is the Expenditure per Sortie Factor (EPSF). The mathematical formula and description of variables as follows:

$$\text{Munitions EPSF} = (REF)(SF)(WL)(WE) \tag{4}$$

where

REF = The role effort factor (REF), or the percent of time the aircraft will fly in this role
SF = The sorties flown factor (SF), or the percent of sorties these munitions will be carried on
WL = The weapon load (WL), or the number of items carried by the aircraft
WE = The weapon expended (WE), or the percent of the time the item will be expended

(35)

The importance of the EPSF is that it is the basis on which consumption rates (CR) are developed. The consumption rate is then directly used in the DOS model.

The consumption rate for fuels is calculated as a function of the role effort factor, and the weight of the associated weapons payload is considered in calculation of the consumption rate applicable to a particular role. The formula and the description of variables is as below:

$$\text{Fuel EPSF} = (CPS)[1+(REF)(SF)(WL)(WE)] \qquad (5)$$

where

CPS = The average consumption for a particular airframe per sortie (CPS) in gallons
REF = The role effort factor (REF), or the percent of time the aircraft will fly in this role
SF = The sorties flown factor (SF), or the percent of sorties these munitions will be carried on
WL = The weapon load (WL), or the number of items carried by the aircraft
WE = The weapon expended (WE), or the percent of the time the item will be expended

Like munitions, the fuels consumption rate (CR) is based on the EPSF, and it is the CR that is used in the DOS model. The letters "CR" denote the consumption rate used in the model.

Mission Length (ML). "ML" stands for the length of the mission to be flown in hours. The mission length is not used in the munition DOS calculations, because it has no effect on the expenditure of weapons. Whatever munitions loaded on an aircraft are considered expended (for purposes of modeling), irregardless of mission length. However, mission length is used in calculating the expenditure per mission for fuel consumption. Mission length is multiplied by the consumption rate per hour to provide the expenditure per mission for fuels.

Expenditure Per Mission (EPM). The expenditure per mission of a consumable is the overall amount used in the duration of a mission. Expenditure per mission is the same as the consumption rate for munitions, but the fuels expenditure per mission figure is a product of CR times ML. The model uses "EPM" to denote expenditure per mission in the model formula.

## Write Report Generator Implementing Model

The first programming decision was selection of the programming tool. For this programming task, the tool must be able to manipulate simple mathematics, manage a large database, print reports, and be capable of creating menus that were very easy to use. As a programming tool, dBASE

III+$^{TM}$, had the capabilities required and was both available and familiar to the programmer, and was selected on this basis.

Following selection of the programming tool, the report generator modular program design was done. A modular program design is a dBASE$^{TM}$ term for a programming tree or "wiring schematic" of the anticipated program modules. A copy of the schematic is included as Appendix F. The original design visualized the program as having thirty-five modules and ten fully normalized databases. Normalization of a database is the practice of storing data in such a way as to minimize redundancy of information. A database is said to be fully normalized when it is in "third normal form."

Rèport formats were then drafted and sent by way of telefax to the sponsor unit, Sixteenth Air Force (16AF) (Torrejon AB Spain), for comments. Comments and requested changes were sent back within two weeks by way of the Department of Defense Network (DDN), and incorporated in the report formats. At this point, programming psuedocode (a list of tasks in logical order) was written to guide the actual programming. The prototype ended up with thirty-two modules and fourteen databases. The first ten databases along with two new ones were fully normalized (in third form), but two of the last were not. The structure and field names of the databases are included as Appendix B.

After the report generator program was developed, the debugging process began. Frequent comparisons between the final output and the initial program design were made. The report generator program was rewritten as needed to meet program plan requirements.

Pre-test DOS Report Generator

With the prototype ready for testing, an operational definition was needed to measure the validity of the program. The operational definition developed is as follows: **The Report Generator is operationally defined as a computer software package which accurately calculates "days of supply" on a daily basis in command post exercises.** The following series of tests and their results were all measured against this definition for validation.

At this point, a single Air Force air base database was developed with which to conduct a test. This test scenario was a purely hypothetical test database, with some attempt at remaining in the realm of feasibility. The test database is included as Appendix C.

Following the run of the program using the test scenario, the report generator was evaluated to discover any programming errors, and measured against the operational definition. Because the test scenario was relatively simple, hand calculation of the "days of supply" was

possible. After completing this calculation, a comparison of the manual and LOGDOS produced "days of supply" was made to validate the computer program results.

After satisfying the initial validation process, the report generator Users' Manual (or instruction booklet) was written. The last phase of the pre-test included having a relational database expert evaluate the report generator and suggest changes. Selection of the expert was made amoung the small group of AFIT professors knowledgeable on dBASE III+™. The criteria for selection was availability, system knowledge, and willingness to get involved in the project. At this point a rewrite of both the report generator and the report generator instruction booklet was required and a final pre-test accomplished.

Test DOS Report Generator in a Field Simulation

As previously noted, the sponsor unit for this thesis was Sixteenth Air Force (16AF). As a part of the evaluation, the prototype of the report generator was taken to 16AF for simulation of a command post exercise. The report generator was personally used by the author during the simulation in the 16AF Mission Support Center (MSC). In addition, seven of 16AF personnel agreed to examine the report generator and provide feedback. The selection criteria for individuals taking part in this test was computer familiarity, understanding of the logistics aspect of command post exercises, and a willingness to participate.

Following the use and examination of the report generator, a questionnaire (designed to elicit report generator upgrade information) was administered. The questionnaire is attached as Appendix D.

The last facet of the test, was to formally interview the sponsor unit Director of Logistics and Director of Operations as to their comments and suggestions.

## Chapter Summary

The third chapter covers the specific methodology to be used in the development and execution of this thesis. The methodology's specific steps were a four phase process. The first phase was model development, the second included writing the report generator computer program, the third phase detailed the pre-test of the report generator, and the chapter ended with a discussion of the field simulation test of the report generator.

## IV. Findings and Discussion

### Introduction

In a effort to understand and organize the development of the model and report generator up to this point, a summary of the work thus far and of the survey conducted at 16AF and mentioned in Chapter III is needed. First, this chapter returns to the original investigative questions and summarizes the answers found. The chapter ends with an overview of users' survey results.

### Investigative Questions

In Chapter I, seven investigative questions were used to guide development of a working "days of supply" model and software production of a report generator implementing the model. First, the following questions were used to direct model building:

1. What is a "days of supply" calculation and what variables must be included?
2. What given, constant values must be included?
3. How are these given, constant values derived, and what goes into their formulation?

First of all, just what is a "days of supply" (DOS)? A DOS is a warfighting capability measurement, as previously stated. To put this in other words, the DOS is how long (in days) a unit can fight at a specified level of effort. Quantitatively, a DOS is simply the count of consumable(s)

available divided by how much one planned to use per day. This delivers a rough DOS, or how many days one could continue to operate at that level of effort.

This calculation seems quite simple, but the complexity lies within its variables. The initial formula then appears as :

$$DOS = \frac{C}{U} \tag{6}$$

where

DOS = days of supply
C = amount of consumable on hand
U = consumables used in a day

Breaking the equation apart, one variable at a time, one can understand the complexity better. "C" or the amount of consumable on hand is the easiest variable to obtain. A simple count or measurement of the amount physically on hand provides the number needed. The denominator in the equation is the more difficult to obtain. From the literature review, one can see many combinations of variables assembled with this is mind. However, the predominate variables used to obtain a "U" figure were:

1. The associated consumption rate,
2. Number of aircraft flown, and
3. The sortie rates.

In the different models other variables played a part in the calculations, such as variables representing uncertainty, but the three variables above were the basic building blocks of any logistic capability measurement. The "U" then is represented mathematically as:

$$U = (EPM)(A)(S) \tag{7}$$

where

EPM = Expenditure per mission
A = Number of mission capable aircraft of one type, all flying a specific mission
S = Sortie rate

First, one needs to determine what the level of consumption is per mission, or the expenditure per mission. The level of consumption is driven by given, constant values such as the EPSF. Basically the expenditure per mission is either a product of the consumption rate multiplied by the mission length (to calculate fuel EPM) or the expenditure per mission is the consumption rate (to calculate munition EPM), therefor:

$$EPM = (CR)(ML) \tag{8}$$

where

EPM = Expenditure Per Mission
CR = Consumption rate of a consumable per hour for specified aircraft in specified role
ML = Length of mission in a specified role

or:

$$EPM = CR \tag{9}$$

where

EPM = Expenditure Per Mission
CR = Consumption rate of a consumable per mission for specified aircraft in a specified role

Determining "A" in equation (7) or the number of mission capable aircraft on hand is easier to obtain. A simple count of the mission capable aircraft of a single type, all flying a specific role provides this variable. Getting the "S" is also simple to determine. Sortie rates are established by individual commands for each aircraft in each of its possible roles. These sortie rates are published and available for insertion in the equation. Putting it all together the overall DOS model formula appears this way:

$$DOS = \frac{C}{(EPM)(A)(S)} \tag{10}$$

where

DOS = Days of Supply
C = Amount of consumable on hand, like gallons of fuel (consistent measure)
EPM = Expenditure per mission = CR x ML or EPM = CR for munitions
CR = Consumption rate of a consumable per hour for specified aircraft in specified role, "given" for a specific aircraft/role
ML = Length of mission in a specified role
S = Sortie Rate, "Given" for a specific role
A = Number of mission capable aircraft of one type, all flying a specific role

(14)

Once the model was built, the second set of investigative questions were addressed in development of the report generator software program:

1. What type of a software program will address the problem as stated?

2. What type of hardware should the report generator be written for?

3. What programming language and techniques should be used?

4. What information should be on the reports produced by the report generator?

Answering question number one, selecting a programming tool, was the first programming decision. For this programming task, the tool must be able to manipulate simple mathematics, manage a large database, print reports, and be capable of creating menus that were very easy to use. As a programming tool dBASE III+™ had the capabilities required and was both available and familiar to the programmer, and thus was selected on this basis.

Addressing question number two was a matter of determining the type of hardware available to the users. Air Force wide adoption of IBM pcs, and the commonalty of the Zenith 200s, 248, and 348s worldwide in Air Force Logistics offices, made hardware selection simple. The program was written for IBM compatible machines, and compiled to allow the program to operate directly, without an additional program.

Question three was partially answered during the response to question one during concerning selection of a programming tool -- dBASE III+TM. The chief dBASE technique used in development of the report generator was the modular program design approach. First, report formats were drafted and sent by way of telefax to the sponsor unit, Sixteenth Air Force (16AF) (Torrejon AB Spain), for comments. Comments and requested changes were sent back and incorporated in the report formats. At this point, programming psuedocode (a list of tasks in logical order) was written to guide the actual programming. The prototype ended up with thirty-two modules and fourteen databases. The first ten databases along with two new ones were fully normalized (in third form), but two of the last were not.

After the report generator program was developed, the debugging process began. Frequent comparisons between the final output and the initial program design were made. The report generator program was rewritten as needed to meet program plan requirements.

With the prototype ready for testing, an operational definition was developed as an aid in measuring the validity of the program. To conduct the test, a hypothetical Air Force base database was developed. This test scenario was a purely hypothetical test database, with some attempt at remaining in the realm of feasibility.

Following the run of the program using the test scenario, the report generator was evaluated to discover any programming errors, and measured against the operational definition. Because the test scenario was relatively simple, hand calculation of the "days of supply" was possible. After completing this calculation, a comparison of the manual and LOGDOS produced "days of supply" was made to validate the computer program results. The initial comparison indicated errors in the programming logic. These errors were corrected, and the test rerun. The results were again compared and found to be identical.

After satisfying the initial validation process, the report generator Users' Manual (or instruction booklet) was written. The last phase of the pre-test included having a relational database expert evaluate the report generator and suggest changes. At this point a rewrite of both the report generator and the report generator instruction booklet was required and a final pre-test accomplished.

As previously noted, the sponsor unit for this thesis was Sixteenth Air Force(16AF). As a part of the evaluation, the prototype report generator was taken to 16AF for simulation of a command post exercise. The report generator was personally used by the author during the simulation in the 16AF Mission Support Center (MSC). In addition, seven of 16AF personnel agreed to examine the report generator and provide feedback. The selection criteria for individuals

taking part in this test was computer familiarity, understanding of the logistics aspect of command post exercises, and a willingness to participate. Following the use and examination of the report generator, a questionnaire (designed to elicit report generator upgrade information) was administered.

The last facet of the test, was to formally interview the sponsor unit Director of Logistics and Director of Operations as to their comments and suggestions.

The final investigative question concerns the information included on the reports generated by the report generator. The information needed on the reports was initially decided to be:

1. The base name
2. The "as of" date
3. The "days of supply" calculation
4. Some sort of breakdown of the DOS to allow meaningful user analysis of the DOS

Three reports were drafted: 1) a fuels report, 2) a munitions report, and an 3) overall base DOS report.

Table 1 shows report number one, which provides the following information:

TABLE 1

SAMPLE FUELS REPORT FORMAT

---

TEST AIR BASE

FUEL DAYS OF SUPPLY (DOS) REMAINING
BASED UPON XX/XX/XX
SORTIE RATES AND EXPENDITURE RATES

TEST AIR BASE HAS X.XXX DAYS OF SUPPLY REMAINING

WHICH AMOUNT TO XXXXXXX GALLONS
OR XXXXX BARRELS

. PER DAY FUEL USE BY TYPE OF AIRCRAFT/ROLE:

| AIRCRAFT/ROLE | PER DAY USE IN GALS |
|---|---|
| XXX/XXXXXXXXXXXXXX | XXXXX.XXX |

---

The munitions report, report number two appears in Table 2:

TABLE 2

SAMPLE MUNITIONS REPORT FORMAT

---

TEST AIR BASE

FUEL DAYS OF SUPPLY (DOS) REMAINING
BASED UPON XX/XX/XX
SORTIE RATES AND EXPENDITURE RATES

TEST AIR BASE HAS X.XXX DAYS OF SUPPLY REMAINING

PROJECTED MUNITION EXPEND PER DAY ACROSS AIRCRAFT TYPES:

| MUNITION: | PER DAY CONSUMPTION: | LIMITING MUNITION? |
|---|---|---|
| XXXXX | XXXX.XXX | YES |
| XXXXX | XXXX.XXX | NO |

---

The last report, Table 3, is the overall base DOS report:

TABLE 3

SAMPLE OVERALL BASE DOS REPORT FORMAT

TEST AIR BASE

FUEL DAYS OF SUPPLY (DOS) REMAINING
BASED UPON XX/XX/XX
SORTIE RATES AND EXPENDITURE RATES

TEST AIR BASE LIMITING FACTOR IS XXXXXXXXX

| FUEL DAYS OF SUPPLY ARE: | MUNITIONS DAYS OF SUPPLY ARE: |
|---|---|
| XX.XXX | XX.XXX |

Users' Survey Results

Seven individuals were surveyed at the sponsor unit, but only six returned the surveys. The results of the survey were encouraging, and offered solid recommendations for further improvements.

Table 4 summarizes the demographic survey results:

TABLE 4

SURVEY DEMOGRAPHICS

| | | | | | |
|---|---|---|---|---|---|
| 1. PAY GRADE | O6: 2 | O4,O5: 1 | O1-O3: 2 | E7-E9: 1 | |
| 2. ACTIVE DUTY TIME(YEARS) | >=25: 1 | <25>=20: 1 | <20>=15: 1 | <15>=11: 1 | <11>=6: 2 |
| 3. COMPUTER USE & FAMILIARITY | USE COMPUTER 2-3 TIMES A WEEK: 1 | | | USE DAILY: 5 | |

Survey Demographics. Two colonels, one major, two captains, and one master sergeant participated in the survey. All of the survey participants had greater than six years in service, with four out of the six participants having greater than eleven years in the service. Five out of the six rated their computer usage/familiarity as being daily -- including both colonels. The sixth individual placed himself in the two to three times a week category.

The surveyed population as a group were individuals with a high level of military experience, who where also familiar with computers. A summary of the results of the survey is summarized in Table 5 to follow.

TABLE 5

SURVEY RESULTS*

| Question: | Response: | Number of Respondents: |
|---|---|---|
| 4. USE OF DOS REPORT GENERATOR | USED THE PROGRAM, AND REPORTS | - 2 |
| | USED THE PROGRAM, BUT NOT REPORTS | - 1 |
| | DID NOT USE PROGRAM, WOULD USE REPORTS | - 3 |

Key for Questions 5 Through 12

1 OUTSTANDING
2 ADEQUATE
3 NO OPINION
4 INADEQUATE
5 VERY POOR

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 5. PROGRAM MENUS | 2 | 1 | | | |
| 6. EASE OF USE OF PROGRAM | 2 | 1 | | | |
| 7. TERMINOLOGY USED IN PROGRAM | 1 | 2 | | | |
| 8. PROGRAM DOCUMENTATION | 1 | 1 | 1 | | |
| 9. PERSONAL CONFIDENCE IN PROGRAM RESULTS | 2 | 1 | | | |
| 10. READABILITY OF PROGRAM REPORTS | 3 | 2 | 1 | | |
| 11. APPLICABILITY OF PROGRAM REPORT RESULTS | 4 | 1 | | | |
| 12. PERSONAL CONFIDENCE IN PROGRAM REPORT RESULTS | 3 | 2 | | | |

* SURVEY RESPONDENTS MARKING ANY ANSWER IN QUESTION #4 OTHER THAN THE FIRST RESPONSE, WHERE NOT REQUIRED TO FULLY RESPOND TO QUESTIONS 5 THROUGH 12.

Survey Results. All but one of the survey participants reported they would use the generated reports. Concerning the program itself, the user response was uniformly favorable. The survey sought opinions through a five point Likert scale on 1) program menus, 2) user friendliness, 3) terminology used in the program, 4) program documentation, 5) user confidence in program, 6) readability of reports, 7) applicability of program report results, 8) user confidence in reports, and 9) general comments.

With the exception of a single "no opinion" response on 4) program documentation and 6) readability of reports, the respondents found the report generator adequate to outstanding. Verbal comments were also favorable, the words "...easy to use" appeared on two of the survey comment blocks. A number of suggestions were made to improve/change the program:

1. Rewrite the program to run off two 3.5 disks -- then the program can be used on the portable, TEMPEST approved Zenith computer.

2. Drop one decimal place off DOS output -- the extra one is not meaningful.

3. Standardize hyphen usage in the munitions database.

4. Rewrite the program to include pop-up menus for selection of aircraft, munition, and fuel types -- having the user type in these takes too much time and errors are frequent.

5. Change reports to include a number of sorties available, based on consumables on hand.

6. Change awkward wording on program update screens.

7. Rewrite the program to allow reports to come to the screen before printing -- the user may not want a hard copy of every report.

8. Change wording on fuels reports to use more acyronyms -- spelling things out is not needed.

9. Change reports to include a summary of the input mission data -- particularly the number of aircraft and the sortie rate and length.

10. Change fuels expenditure rate field to five spaces -- the field was incorrectly sized for the data to be input.

The program on the whole was received favorably and the users offered enthusiastic support as well as many constructive observations.

## Chapter Summary

Chapter IV consolidates the information uncovered during the literature review and relate this to the desired model described and tested in Chapter III. To do this, first, Chapter IV returned to the original investigative questions and summarized the answers to these questions. The final part of the chapter examines and analyzes the results of the users' survey briefly discussed in Chapter III.

# V. Conclusions and Recommendations

## Conclusions

After establishing the need, and presenting background material on calculating a "days of supply" (DOS) figure/report and report generator, this thesis outlined the development and implementation of the project.

A literature search of the available and related literature revealed information on modeling, mathematical methods, and program implementation methods. The DOS model was then developed using variables revealed during research, and the model incorporated in the report generator. The programming tool used for the report generator was dBASE III+™, using R & R Relational Report Writer™ for the actual reports, and Clipper™ to compile the finished product.

The report generator was developed in close coordination with the sponsor unit, Sixteenth Air Force (16AF), and was taken there for prototype testing. A users' survey was administered and the sponsor unit Director of Logistics and Director of Operations were interviewed as to their comments and suggestions.

The report generator as developed requires three 5.25 floppy disks (each with a 360 kilobyte capacity) and is designed to be installed by the user on an IBM-compatible microcomputer. Since the program has been compiled, the

program is a stand-alone program that will operate on any IBM-compatible microcomputer with 640K RAM, one 5.25 floppy drive, a hard disk, a monitor (monochrome or color), and an 80-column printer capable of using continuous-form feed.

Recommendations

A number of recommendations follow for the improvement and expansion of the current version of the Logistics Days of Supply (LOGDOS) report generator. The first, includes incorporation of some of the programming suggestions made by the sponsor unit. The second is to continue work on the project with the sponsor unit, and finally look at possible applications to other areas of the model and report generator program.

Program Changes. In addition to the recommended changes by the sponsor unit (included in Chapter IV), four addition programming changes require mention:

1. The program needs to be expanded to handle more than one base at a time. The current version can only handle one base without a programming change. 2. The current screen color setting need to be change. The current color combination allows the cursor symbol to fade out on the Zenith 150 monochromatic screen.

3. The munition expenditure field, in both the program and the databases, must be enlarged to allow the proper expenditure rates for 20mm, 30mm, 40mm, and 50mm ammunition. Currently, the user must input the level in thousands of rounds, for example 100 means 100000 rounds.

4. When the program encounters a munition type currently on station -- but not being used in a mission cycle sequence -- the program outputs a DOS for that munition based on the last time the munition was used. The program needs to annotate the unused munition(s) accordingly, and perhaps list the available level.

Program Continuation. The sponsor unit has expressed an enthusiastic interest in continuing the programming effort with a thesis student from the next Air Force Institute of Technology class. In addition to the aforementioned program changes, 16AF desires assistance in integration of this program into a system under design, development, and application in their organization. The ultimate goal of this system, called the Resource Management System (RMS), is to facilitate command wide integration of the system with Headquarters United States Air Force, Europe (USAFE), and ultimately Air Force Logistics Command (AFLC).

Further Applications. The possibility of using the DOS model as a blueprint for modeling other activities which monitor consumables exists. The key to this application lies in identification of the "measure of merit," or the

consumable, that means the difference between stop and go for the activity or unit adapting the model. Once this "measure of merit" has been identified, the process becomes a matter of plugging in the appropriate formula into the model and a copy of the programming code.

Possible areas of application include Security Police and Rapid Runway Repair. Although supply seems to be an obvious application choice, the area may be too difficult. First of all, there are no hard and fast consumption rates for most items, not all items are directly related to sorties flown, and determining which items are critical (stop or go items) is a subjective judgment call.

## Chapter Summary

The LOGDOS Report Generator supplies logistics and operations planners a uniform, efficient and accurate way of calculating a DOS for command post exercises or wartime use. With the recommended changes and pursuit of further applications, the program should have an impact on the way logisticians calculate sustainability and help close the gap between what, where, and how much is needed, and **knowing** what, where, and how much is needed.

## Appendix A: Glossary of Terms

AMMUNITION CONTROL POINT (ACP). The ACP acts as the worldwide, vertically integrated management for munitions stocks.

ANALYTICAL MODEL. Analytical models are models which use mathematics to assess scenarios and large-scale systems (30:5).

AVIATION FUEL CAPABILITY ASSESSMENT MODEL (AFCAM). AFCAM is a U.S. Air Force software program that produces an aggregate assessment capability for aircraft fuels.

BAYESIAN. Bayesian refers to mathematician Thomas Bayes's methods of calculating and representing probabilities (24:1089).

COMBAT AMMUNITION SYSTEM (CAS). The CAS is an inventory management system designed to provide a worldwide, vertically integrated management structure.

CONSUMABLE. Items consumed in performance of the flying mission, such as fuel, munitions, film, and liquid oxygen.

CONSUMPTION PER SORTIE (CPS). The average consumption for a particular airframe per sortie in gallons.

CONSUMPTION RATE. The consumption rate is measured in sorties or by flying hour and indicates the amount of consumable used.

DAYS OF SUPPLY (DOS). Days of Supply (DOS) is a logistics, warfighting, capability measurement based on the type/number of aircraft flown, associated sortie rates, and consumption rate (for all consumables)--at a given time--based on projected roles and sorties.

DESIGN REFERENCE MISSION (DRM). A model under development by the U.S. Navy designed to assess operational availability of combat capability.

ENABLE. ENABLE is a commercially available database management software package.

END ITEM. A final combination of end products, component parts and/or materials which is ready for the intended use (11:254).

ENHANCED SORTS CAPABILITY ASSESSMENT MODEL (ESCAM). ESCAM is a U.S. Air Force model designed to assess combat readiness and forecasts of sustainability from an operational point of view.

EXPENDITURE PER SORTIE FACTOR (ESPF). An expenditure per munition or consumption rate established by the using Air Force command.

LIKERT SCALE. A Likert scale is a summated scaling method used in surveys. The respondent is given the option on a survey to agree or disagree with each statement, and provided a numerical option to reflect the degree of agreement (or disagreement) with the statement.

LOGISTICS CAPABILITY MEASUREMENT SYSTEM (LCMS). A U.S. Air Force family of models designed to assess combat capability.

LOGGIE. A slang term used to refer to logistics staff agencies and their personnel. The functional areas referred to include logistics plans, maintenance, munitions, supply, and transportation.

MATHEMATICAL TRANSFORMATION. Mathematical transformation is a calculus technique used in integration to estimate expected changes of variables (26:90).

MODEL. A model is a set of rules or assumptions about a designated scenario and how these rules/assumptions are linked within the scenario.

MODULAR PROGRAM DESIGN. A programming method which is based on breaking the programming task into modules which perform specific tasks.

MONTE CARLO. Monte Carlo refers to a type of simulation.

NOT FULLY MISSION CAPABLE (NFMC). A status code meaning that the system or equipment cannot perform all of its primary missions.

NORMALIZATION. Is the practice of storing data in such a way as to minimize redundancy of information. A database is said to be fully normalized when it is in "third normal form." A database in "third normal form" has all redundant data, partial dependencies and transitive dependencies removed.

Database files having more than one key field and the data in a record is not directly relevant to all the key fields are said to have partial dependencies.

In database files where transitive dependencies exist fields are occasionally dependent on some other nonkey key field within a single record.

OPERATORS. Rated flying officers serving as planners in warplanning staff agencies.

PRINCIPAL ITEM(S). Items are generally designated as such on the basis of military essentiality, high monetary value, difficulty of procurement and production, unduly short or excessive supply position, and the criticality of basic materials or components (11:539).

PSUEDOCODE. A term used in dBASE programming. Refers to a list of tasks in logical order, written to act as guide or road map for the programmer.

QUALITATIVE MODELS. Qualitative models are based on "natural language rules" (9:6) and are not easily translated into numerical equations.

QUANTITATIVE MODELS. Quantitative models use mathematics to establish model rules and variable relationships.

ROLE EFFORT FACTOR (REF). The percent of times an aircraft will fly in a specific role.

REGRESSOR VARIABLE. A regressor variable is the variable on which a calculus regression is done, in order to determine how closely two variables are related.

REPLACEMENT END ITEMS. An end item that is functionally interchangeable with another end item, but differs from the original. The replacement end item may require some modification prior to normal operations (11:582).

REPORT GENERATOR. A computer software package which produces reports featuring input data.

RETROSPECTIVE CALIBRATION. Retrospective calibration is a technique used in assessing model prediction accuracy. Retrospective calibration, by using only data available at a given point in the past, matches predictions against the actual event outcome(s), determining the size of prediction errors (12:12).

ROLE. The role is the type of mission an aircraft flies.

SECONDARY ITEMS. All items in the supply system that are not defined as principle items, These consist of end items, replacement assemblies, parts and consumables (11:613).

SORTIES FLOWN FACTOR (SF). The percent of sorties a munition will be carried on an aircraft.

SIMULATION MODEL. A simulation model represents complex systems and their internal interrelationships.

SORTIE. A sortie is one take-off, mission, and landing of an aircraft.

SORTIE RATE. A sortie rate is aircraft specific, with rate established for all types of aircraft, depending on mission use. For example, a fighter aircraft's sortie rate is established at 3.4. At a 3.4 sortie rate, the fighter flies 3.4 times per flying day.

TANKS, RACKS, AND ADAPTERS (TRAP). TRAP is consumable equipment items required for aircraft sorties.

UNCERTAINTY. Uncertainty in models comes from three sources. First, there is structural uncertainty about the scenario and the model. Second, estimation uncertainty exists when the model and scenario parameters are not known. Lastly, prediction uncertainty exists whether one knows model parameters or not (12:1).

WEAPONS EXPENDED (WE). Weapons expended, or the percent of time the item will be expended or used during a aircraft mission.

WEAPONS LOAD (WL). Weapons load, or the number of items carried by the aircraft.

WEAPONS SYSTEM MANAGEMENT INFORMATION SYSTEM (WSMIS). WSMIS is a an automated modeling tool and management information system which assesses the ability of U.S. Air Force units to sustain warfighting capacity with on hand assets.

WMP. The War Mobilization Plan and is published in five volumes to fufill the USAF requirement for a plan to support the Joint Strategic Capabilities Plan (JSCP) and Department of Defense mobilization and planning directives.

WMP 5. Contains the Basic Planning Factors and Data, sortie and flying hour data, used in planning requirement. WMP 5 contains the approved HQ USAF position on sortie rate/durations/attrition rates and flying hour requirements to support USAF Programmed and Mobilization force levels.

## Appendix B: Structure for Database

DATABASE: MBF

| FIELD | FIELD NAME | TYPE | WIDTH | DEC |
|---|---|---|---|---|
| 1 | BASE_NUM | CHARACTER | 5 | |
| 2 | BASE_NAM | CHARACTER | 25 | |

DATABASE: M

| FIELD | FIELD NAME | TYPE | WIDTH | DEC |
|---|---|---|---|---|
| 1 | BASE_NUM | CHARACTER | 5 | |
| 2 | MUNITION | CHARACTER | 15 | |
| 3 | MQUANTITY | NUMERIC | 15 | |
| 4 | PDUM | NUMERIC | 13 | 3 |
| 5 | LM | LOGICAL | 1 | |

DATABASE: AC

| FIELD | FIELD NAME | TYPE | WIDTH | DEC |
|---|---|---|---|---|
| 1 | BASE_NUM | CHARACTER | 5 | |
| 2 | AIRCRAFT | CHARACTER | 7 | |
| 3 | ACQUANT | NUMERIC | 3 | |

DATABASE: P

| FIELD | FIELD NAME | TYPE | WIDTH | DEC |
|---|---|---|---|---|
| 1 | BASE_NUM | CHARACTER | 5 | |
| 2 | FUEL | CHARACTER | 7 | |
| 3 | PQUANTITY | NUMERIC | 15 | |

DATABASE: AF

| FIELD | FIELD NAME | TYPE | WIDTH | DEC |
|---|---|---|---|---|
| 1 | BASE_NUM | CHARACTER | 5 | |
| 2 | AIRCRAFT | CHARACTER | 7 | |
| 3 | ROLE | CHARACTER | 15 | |
| 4 | FUEL | CHARACTER | 7 | |

DATABASE: **AM**

| FIELD | FIELD NAME | TYPE | WIDTH | DEC |
|---|---|---|---|---|
| 1 | BASE_NUM | CHARACTER | 5 | |
| 2 | AIRCRAFT | CHARACTER | 7 | |
| 3 | ROLE | CHARACTER | 15 | |
| 4 | MUNITION | CHARACTER | 15 | |

DATABASE: **AQ**

| FIELD | FIELD NAME | TYPE | WIDTH | DEC |
|---|---|---|---|---|
| 1 | BASE_NUM | CHARACTER | 5 | |
| 2 | AIRCRAFT | CHARACTER | 7 | |
| 3 | ROLE | CHARACTER | 15 | |
| 4 | AQQUANT | NUMERIC | 3 | |

DATABASE: **K1**

| FIELD | FIELD NAME | TYPE | WIDTH | DEC |
|---|---|---|---|---|
| 1 | AIRCRAFT | CHARACTER | 7 | |
| 2 | ROLE | CHARACTER | 15 | |
| 3 | SORT_RAT | NUMERIC | 4 | |
| 4 | SORT_LEN | NUMERIC | 4 | 2 |

DATABASE: **K2**

| FIELD | FIELD NAME | TYPE | WIDTH | DEC |
|---|---|---|---|---|
| 1 | MUNITION | CHARACTER | 15 | |
| 2 | AIRCRAFT | CHARACTER | 7 | |
| 3 | MEXPEND | NUMERIC | 4 | 2 |
| 4 | ROLE | CHARACTER | 15 | |

DATABASE: **K3**

| FIELD | FIELD NAME | TYPE | WIDTH | DEC |
|---|---|---|---|---|
| 1 | AIRCRAFT | CHARACTER | 7 | |
| 2 | FUEL | CHARACTER | 7 | |
| 3 | FEXPEND | NUMERIC | 6 | |
| 4 | ROLE | CHARACTER | 15 | |

DATABASE: **M1**

| FIELD | FIELD NAME | TYPE | WIDTH | DEC |
|---|---|---|---|---|
| 1 | BASE_NUM | CHARACTER | 5 | |
| 2 | MUNITION | CHARACTER | 15 | |
| 3 | MQUANTITY | NUMERIC | 15 | |
| 4 | PDUM | NUMERIC | 13 | 3 |
| 5 | LM | LOGICAL | 1 | |
| 6 | TCONSUM | NUMERIC | 13 | 3 |

DATABASE: **FREPOR**

| FIELD | FIELD NAME | TYPE | WIDTH | DEC |
|---|---|---|---|---|
| 1 | BASE_NUM | CHARACTER | 5 | |
| 2 | FUEL | CHARACTER | 7 | |
| 3 | AIRCRAFT | CHARACTER | 7 | |
| 4 | ROLE | CHARACTER | 15 | |
| 5 | PDUF | NUMERIC | 13 | 3 |
| 6 | LF | LOGICAL | 1 | |
| 7 | CONSUM | NUMERIC | 13 | 3 |

DATABASE: **MUNREPOR**

| FIELD | FIELD NAME | TYPE | WIDTH | DEC |
|---|---|---|---|---|
| 1 | BASE_NUM | CHARACTER | 5 | |
| 2 | MUNITION | CHARACTER | 15 | |
| 3 | AIRCRAFT | CHARACTER | 7 | |
| 4 | ROLE | CHARACTER | 15 | |
| 5 | PDUM | NUMERIC | 13 | 3 |
| 6 | LM | LOGICAL | 1 | |
| 7 | CONSUM | NUMERIC | 13 | 3 |

DATABASE: **SPECS**

| FIELD | FIELD NAME | TYPE | WIDTH | DEC |
|---|---|---|---|---|
| 1 | PDUF | NUMERIC | 13 | 3 |
| 2 | PDUM | NUMERIC | 13 | 3 |
| 3 | BASE_DOS | CHARACTER | 9 | |
| 4 | B_NAME | CHARACTER | 25 | |

## Appendix C: Test Database

**Base Name:** CAROLINA AB

**Number and Type of Aircraft:** 18 each F-16
24 each F-15E

| **Sortie Rates:** | **F-16** | **F-15E** |
|---|---|---|
| AIR SUPERIORITY | 3.4 | 3.2 |
| AIR-TO-GROUND | 3.2 | |
| INTERDICTION(AW | | 3.0 |

**Length of Missions:**
(in hours)

| | F-16 | F-15E |
|---|---|---|
| AIR SUPERIORITY | 1.25 | 1.5 |
| AIR-TO-GROUND | 1.5 | |
| INTERDICTION(AW | | 2.1 |

**Consumption Rate for Fuel:**

| | F-16 | F-15E |
|---|---|---|
| AIR SUPERIORITY | .0016 | .015 |
| AIR-TO-GROUND | .0016 | |
| INTERDICTION(AW | | .025 |

**Consumption Rate for Munitions:**

| All roles: | F-16 | F-15E |
|---|---|---|
| MK-82 | 4 | 6 |
| MJU7B | 4 | |
| RR180 | 4 | 4 |
| DURANDAL | 16 | 10 |
| MK-84 | 2 | 4 |
| 20mm | 10000 | 10000 |
| CBU52 | 4 | 6 |
| CBU58 | 4 | 6 |
| MK20 | 4 | 6 |
| CBU97/SFW | 2 | 4 |
| GBU12 | 4 | 4 |
| GBU10 | 2 | 4 |
| GBU24 | 2 | 2 |
| AGW/I2K/84 | 2 | 4 |
| AGM65 | 2 | 2 |
| GBU15IR | | 1 |
| BLU109B | 2 | 4 |
| AIM120A | 1 | |

**Consumption Rate for Munitions:**

| All roles: | F-16 | F-15E |
|---|---|---|
| AIM7M | 1 | 1 |
| AIM9M | 1 | 1 |
| AIM7E | | 1 |

**On Hand Fuel:** 3,000,000 gallons

**On Hand Munitions:**

| | |
|---|---|
| MK-82 | 150 |
| MJU7B | 150 |
| RR180 | 150 |
| DURANDAL | 3000 |
| MK-84 | 300 |
| 20MM | 300000 |
| CBU52 | 150 |
| CBU58 | 150 |
| MK-20 | 150 |
| CBU97 | 150 |
| GBU12 | 150 |
| GBU10 | 150 |
| GBU24 | 150 |
| AGW/I2K | 150 |
| AGM65 | 150 |
| GBU15IR | 150 |
| BLU109B | 25 |
| AIM120A | 30 |
| AIM7M | 30 |
| AIM9M | 30 |
| AIM7E | 30 |

**AIRCRAFT FLYING ACTIVITY:**

| | | | MUNITIONS: |
|---|---|---|---|
| DAY 1: | 8 F-16 | FLY AIR SUPERIORITY | MISSILES, 20MM |
| | 8 F-16 | FLY AIR-TO-GROUND | MK82,84,GBUs,20MM |
| | 4 F-15E | FLY INTERDICTION(AW | MK82,84,GBUs,20MM |
| | 6 F-15E | FLY AIR SUPERIORITY | MISSILES, 20MM |
| DAY 2: | 8 F-16 | FLY AIR SUPERIORITY | MISSILES, 20MM |
| | 8 F-16 | FLY AIR-TO-GROUND | MK82,84,GBUs,20MM |
| | 12 F-15E | FLY INTERDICTION(AW | MK82,84,GBUs,20MM |
| | 6 F-15E | FLY AIR SUPERIORITY | MISSILES, 20MM |

LOSS: 1 F-16, 2 F-15s OUT OF COMMISSION

| | | | | MUNITIONS: |
|---|---|---|---|---|
| DAY 3: | 7 | F-16 | FLY AIR SUPERIORITY | MISSILES, 20MM |
| | 8 | F-16 | FLY AIR-TO-GROUND | MK82,84,GBUs,20MM |
| | 4 | F-15E | FLY INTERDICTION(AW | MK82,84,GBUs,20MM |
| | 6 | F-15E | FLY AIR SUPERIORITY | MISSILES, 20MM |

1 F-15E BACK IN COMMISSION

| | | | | |
|---|---|---|---|---|
| DAY 4: | 7 | F-16 | FLY AIR SUPERIORITY | MISSILES, 20MM |
| | 8 | F-16 | FLY AIR-TO-GROUND | MK82,84,GBUs,20MM |
| | 12 | F-15E | FLY INTERDICTION(AW | MK82,84,GBUs,20MM |
| | 5 | F-15E | FLY AIR SUPERIORITY | MISSILES, 20MM |

LOSS: 2 F-16, 1 F-16 OUT OF COMMISSION

| | | | | MUNITIONS: |
|---|---|---|---|---|
| DAY 5: | 6 | F-16 | FLY AIR SUPERIORITY | MISSILES, 20MM |
| | 8 | F-16 | FLY AIR-TO-GROUND | MK82,84,GBUs,20MM |
| | 12 | F-15E | FLY INTERDICTION(AW | MK82,84,GBUs,20MM |
| | 5 | F-15E | FLY AIR SUPERIORITY | MISSILES, 20MM |

# Appendix D: DOS Survey

DAYS OF SUPPLY REPORT GENERATOR
SURVEY OF USERS

This survey is designed for gathering information from the users and sponsors of the Days of Supply Report Generator Program, in order to improve subsequent versions. All responses are anonymous.

## General Instructions

1. Please answer each question as best you can. Select the answer which best describes your response.

2. Please score you response directly on the survey itself.

3. I encourage you to use the comments section to elaborate on anything I might have missed. This feedback is vital to improving future versions of the report generator.

4. After completing the survey, please return it to Capt C. Duckett. Thank you for your help!

SURVEY

1. What is your current pay grade?

______ 06 or above (or civilian equivalent)
______ 04,05 (or civilian equivalent)
______ 01 - 03 (or civilian equivalent)
______ E7 - E9 (or civilian equivalent)
______ E4 - E6 (or civilian equivalent)
______ E1 - E3 (or civilian equivalent)

2. What is your total active duty time?

______ greater than or equal to 25 years
______ greater than or equal to 20, but less than 25
______ greater than or equal to 15, but less than 20
______ greater than or equal to 11, but less than 15
______ greater than or equal to 6, but less than 11
______ greater than or equal to 1, but less than 6
______ less than 1 year

3. How would you rate your computer usage/familiarity?

```
+-------------+-----------+-----------+-----------+
Never use    Use once   Use 4 times   Use 2-3   Use daily
a computer    a month     a month      a week
```

4. Did you use the Days of Supply Report Generator?

____ Yes, and I would use the report(s) generated, too

____ Yes, but I wouldn't use the reports (please skip questions 10, 11 and 12)

____ No, but I would use the generated reports (please skip to question 10)

____ No, and I wouldn't use the generated reports either (please skip to question 13)

Please circle the response which most represents your opinions using the below listed scale:

1 Outstanding
2 Adequate
3 No Opinion
4 Inadequate
5 Very Poor

| | |
|---|---|
| 5. Program Menus | 1-------2-------3-------4-------5 |
| 6. Ease of Use of Program | 1-------2-------3-------4-------5 |
| 7. Terminology Used in Program | 1-------2-------3-------4-------5 |
| 8. Program Documentation | 1-------2-------3-------4-------5 |
| 9. Personal confidence in program results | 1-------2-------3-------4-------5 |
| 10. Readability of Program Reports | 1-------2-------3-------4-------5 |
| 11. Applicability of Program Report results | 1-------2-------3-------4-------5 |
| 12. Personal confidence in Program Report results | 1-------2-------3-------4-------5 |

13. Your comments are welcome. Please elaborate on anything I might have missed:

## Appendix E: Users' Manual

### DAYS OF SUPPLY REPORT GENERATOR
LOGDOS
VERSION 1.1

*** FOR OFFICIAL USE ONLY ***

The DAYS OF SUPPLY REPORT GENERATOR is intended FOR OFFICIAL USE ONLY by the United States Military. Once the user inputs either exercise or real world data, the program takes on the highest classification of input data, Therefore, to be used (other than for test purposes of an unclassified nature) the program MUST BE loaded on a **TEMPEST APPROVED** computer system. Any data downloaded from the system, whether it be software or hard copy reports, must be marked and safeguarded appropriate to the level of security classification. IF YOU HAVE ANY QUESTIONS, SEE YOUR UNIT SECURITY MONITOR.

*** DISCLAIMER OF WARRANTY ***

This software and manual is distributed without any express or implied warranties whatsoever. Because of the diversity of conditions and hardware under which this program may be used, no warranty of fitness for a particular purpose is offered. The user is advised to test the program thoroughly before relying on it. The user must assume the entire risk of using the program.

## TABLE OF CONTENTS

## SYSTEM REQUIREMENTS

Hardware requirements include:

- IBM compatible PC
- 640K RAM capacity
- A floppy drive
- A hard disk drive
- A monitor
- A 80-column printer capable of using continuous form paper

Software requirements include:

- MS-DOS 3.0 or higher
- A Config.SYS file with at least*:

```
FILES=20
BUFFERS=15
```

* See your small computer monitor if you don't know how to check for this file.

# INTRODUCTION

The DAYS OF SUPPLY REPORT GENERATOR is designed for the field logistician for use during command post exercises. The goals of the program are to:

1. Calculate quickly and accurately the number of days a base can continue to operate at current or "what if" activity levels, and
2. To do this in as simple and easy to use format as possible.

The reports generated are designed solely for use in the decision making process as senior logisticians make resource movement decisions and proffer logistics feasibility advice.

# INSTALLATION

There are two basic ways the user can install the Logistics Days of Supply, LOGDOS program. The user can use the INSTALL program contained on Disk A, or do the installations manually.

Using the INSTALL program:

1. First, power up the computer.
2. Insert Disk A into the A drive.
3. At the C: PROMPT type in **B:**.
4. At the B: PROMPT type in **INSTALL**.
5. Follow the on screen instructions.

Manually installing LOGDOS:

1. Power up the computer.
2. At the C: PROMPT type in **MD LOGDOS**
3. Then type in **CD LOGDOS**
4. You should then see C:\LOGDOS
5. Type **COPY A:*.***
6. When the computer returns to C:\LOGDOS, remove Disk A and insert Disk B.
7. Type in **COPY A:*.***
8. When the computer returns to C:\LOGDOS, remove Disk B and insert Disk C.
9. Type **COPY A:*.***
10. When the computer returns to C:\LOGDOS, remove Disk C.
11. Type in **CD..**
12. Type **COPY C:\LOGDOS\DOS.BAT C:**

You are now ready to use LOGDOS.

## PROGRAM STARTUP

Before program startup, ensure that the DAYS OF SUPPLY REPORT GENERATOR has been installed using instructions on page 5. Then carefully work through the menus using this users' guide.

1. To start up type in **DOS** at the C:.

2. The first thing you will see is the 16AF opening screen and the WARNING screen. To get to the first menu, hit <RETURN> or any key. This screen allows the choice of (1) inputting a new base, updating or deleting a base already in the computer, (2) updating base taskings for computer calculations, or (3) actual calculation of the Days of Supply for reports. The different options are explained on the pages to follow.

3. You may exit the program at any menu by using the **QUIT** option listed on the menu. Use of the **QUIT** option returns you to the C: PROMPT.

4. By typing in **DOS**, you go to the startup screens:

```
F O R   O F F I C I A L   U S E   O N L Y


S I X T E E N T H   A I R   F O R C E

        DAYS OF SUPPLY (DOS)

          REPORT GENERATOR

                FOR

       MUNITIONS AND FUELS

            VERSION 1.0

F O R   O F F I C I A L   U S E   O N L Y


       Press any key to continue...
```

W A R N I N G ! !

THIS PROGRAM IS FOR OFFICIAL USE ONLY

ONCE THE USER INPUTS EITHER EXERCISE OR REAL WORLD DATA, THE PROGRAM TAKES ON THE HIGHEST CLASSIFICATION OF INPUT DATA. THEREFORE, TO BE USED (OTHER THAN FOR TEST PURPOSES) THE PROGRAM MUST BE LOADED ON A TEMPEST APPROVED COMPUTER SYSTEM, AND ANY DATA DOWNLOADED FROM THE SYSTEM MUST BE MARKED AND SAFEGUARDED, APPROPRIATE TO THE LEVEL OF SECURITY CLASSIFICATION.

PRESS ANY KEY TO CONTINUE...

INPUT DATABASE

MAIN MENU

1. ADD/UPDATE/DELETE base master record(s)
2. UPDATE base taskings for calculations
3. CALCULATE Days of Supply Reports
4. QUIT

From number 1 off the Main Menu, you can ADD a new base and its resources, UPDATE an existing bases' resources, or DELETE the resources at a base, or DELETE the entire base and its resources from the database.

Having chosen option 1, this screen appears:

```
                 CHANGE BASE MASTER RECORD



     1.  ADD a NEW BASE

     2.  UPDATE an EXISTING base master record

     3.  DELETE a base master record

     4.  RETURN to MAIN MENU

     5.  QUIT
```

1. ADD a new base:

   To add a new base select option 1 from the menu:

```
                 ADD/DELETE NEW BASE MENU



     1.  ADD a new base

     2.  DELETE a new base

     3.  INPUT master base file information

     4.  RETURN to previous menu

     5.  QUIT
```

Here you get a choice of adding, deleting, or inputing data. To add, choose option 1.

At the first input screen you must input the BASE IDENTIFICATION CODE assigned to the base being input.

This code is with the WRM BASE IDENTIFICATION CODE, or the identification code assigned by the exercise OPORD for the purposes of the exercise.

At the BASE NAME, input the name of the base as you wish it to appear on all reports. The name can not exceed 25 letters.

Notes:

1. The program will not allow you to re-input a base, and will tell you if you attempt to do so.
2. The program will also allow you to input more than one base from this part of the program.
3. Ensure you type in all input left-justified. The program won't correctly accept your input if you don't.

## UPDATING THE DATABASE

2. UPDATE a new base:

To update a new or existing base select 2 off the menu (see page 7). Selecting UPDATE will bring you to this screen:

```
                    UPDATE BASE MASTER RECORD

        1.  ADD a FUEL, MUNITION or AIRCRAFT

        2.  UPDATE:    Aircraft NUMBERS,
                       Sortie RATES,
                       Fuel or
                       Munition LEVELS

        3.  DELETE:    Aircraft TYPES,
                       Fuel TYPES or
                       Munition TYPES

        4.  RETURN to PREVIOUS MENU

        5.  QUIT
```

Here you have a choice of adding/updating/deleting aircraft, fuels, or munitions information:

Option 1: Add an aircraft, fuel, or munition.

ADD TO BASE MASTER RECORD

1. ADD Aircraft TYPES
2. ADD Fuel TYPES
3. ADD Munition TYPES
4. RETURN TO PREVIOUS MENU
5. QUIT

From this menu you have the option to add aircraft, fuel, and munition types to a new or existing base.

To add a fuel, munition or aircraft select option 1, and then select the desired number (1 for Aircraft, 2 for Fuel, or 3 for Munition) at the next menu. The first input screen will ask for the BASE IDENTIFICATION CODE (see "ADD a new base" page 9 for an explanation), the aircraft/fuel/munition name (see Appendices A,B, and C respectively for a listing of types), and the quantity of the item to be input at the base.

Notes:
1. This module won't let you update a base that doesn't already exist in the database. You must add first, then update.
2. Ensure you type the aircraft/fuel/munition name exactly like it is listed in the Appendices. Otherwise the program will not recognize the input as valid.
3. Type in all entries left-justified. The program will not take your input otherwise.

**Option 2: Update a fuel, munition or aircraft.**

By choosing option 2 off the Update menu (see page 9), you come to this menu:

```
                UPDATE BASE MASTER RECORD


     1.  UPDATE Aircraft information

     2.  UPDATE Fuels information

     3.  UPDATE Munitions information

     4.  RETURN TO PREVIOUS MENU

     5.  QUIT
```

From this menu you have the option to update aircraft, fuel, and munition types to a new or existing base.

SUB Option 1: Update Aircraft Information.

```
                UPDATE AIRCRAFT INFORMATION


     1.  UPDATE on station Aircraft LEVELS

     2.  UPDATE Aircraft SORTIE RATES/LENGTHS

     3.  UPDATE Aircraft MISSIONS for calculations

     4.  ADD Aircraft TYPE to base master record

     5.  DELETE Aircraft TYPE from base master record

     6.  RETURN TO PREVIOUS MENU

     7.  QUIT
```

From this menu you have the option to update on station aircraft levels, update aircraft sortie rates/lengths, or update base aircraft missions for days of supply calculations:

SUB sub Option 1: Update on station aircraft levels.

To change the number of aircraft at a base select option 1. The first input screen will ask for the BASE IDENTIFICATION CODE (see "ADD a new base" page 9 for an explanation), the aircraft name (see Appendix A for a list of aircraft names), and the quantity of aircraft to be input at the base.

Notes:
1. This module won't let you update a base that doesn't already exist in the database. You must add first, then update.
2. Ensure you type the aircraft name exactly like it is listed in Appendix A. Otherwise the program will not recognize it as a valid aircraft.
3. Ensure you type in all entries left-justified. The program will not take your input otherwise.
4. You must run option 2 off the Main Menu, "Update base taskings for calculations" prior to running reports. See page 13 for information on this part of the program.

SUB sub Option 2: Update aircraft Sortie Rates/Lengths.

To change aircraft sortie rates and sortie lengths select option 2. The first input screen will ask for the aircraft name (see Appendix A for a list of aircraft names), and the mission role to be flown (see Appendix A for a list of roles), and the associated sortie rate and sortie length. These rates come directly out of exercise OPORDs or war plans.

Notes:
1. This module won't let you update an aircraft that doesn't already exist in the database. Ensure you type the aircraft name exactly like it is listed in Appendix A. Otherwise the program will not recognize it as a valid aircraft.
2. Ensure you type in all entries left-justified. The program will not take your input otherwise.
3. This module won't let you input a role that isn't appropriate to an aircraft. Ensure you type the role or mission name exactly as it appears in Appendix A.
4. You must run option 2 off the Main Menu, "Update base taskings for calculations" prior to running reports. See page 13 for this part of the program.

SUB sub Option 3: Update Aircraft Missions for calculations.

To update base mission from the Air Tasking Order (ATO), select option 3. The first input screen will ask for the BASE IDENTIFICATION CODE (see "ADD a new base" page 9 for an explanation), the aircraft name (see Appendix A for a list of aircraft names), the aircraft role (see Appendix A for a list of role), and the quantity of aircraft assigned to this role, the associated sortie rates and mission lengths (in hours), the type of fuel to be used (see Appendix B for a list of fuels), and the types of munitions to be used (see Appendix C for a list of munitions).

Notes:
1. This module won't let you update a base that doesn't already exist in the database. You must add first, then update.
2. Ensure you type the aircraft name exactly like it is listed in Appendix A. Otherwise the program will not recognize it as a valid aircraft.
3. Type in all entries left-justified. The program will not take your input otherwise.
4. This module won't let you input a role that isn't appropriate to an aircraft. Ensure you type the role or mission name exactly as it appears in Appendix A.
5. Ensure you type the fuel name exactly like it is listed in Appendix B. Otherwise the program will not recognize it as a valid fuel.
6. Type the munition name exactly like it is listed in Appendix C. Otherwise the program will not recognize it as a valid munition.
7. This module won't let you input an aircraft/role/munition/fuel combination that isn't valid. Ensure that you use only valid combinations.
8. Sortie rates and lengths come directly out of exercise OPORDs or war plans.
9. You must run option 2 off the Main Menu, "Update base taskings for calculations" prior to running reports. See page 13 for information on this part of the program.

SUB sub Option 4: Add Aircraft type to base master record.

See explanation under the ADD option on page 10.

SUB sub Option 5: Delete Aircraft type from base master record.

See explanation under the DELETE option on page 18.

SUB Option 2: Update Fuels Information.

If you choose update fuels information, select SUB Option 2 off the Update menu (see page 11). You will see this screen:

```
                    UPDATE FUELS INFORMATION

      1.  UPDATE on station Fuels LEVELS

      2.  UPDATE Fuels CONSUMPTION RATES

      3.  ADD Fuel TYPE to base master record

      4.  DELETE Fuel TYPE from base master record

      5.  RETURN TO PREVIOUS MENU

      6.  QUIT
```

From this menu you have the option to update on station fuel(s) levels and update fuel consumption rates.

SUB sub Option 1: Update on station fuels levels.

To change the amount of fuel at a base select option 1. The first input screen will ask for the BASE IDENTIFICATION CODE (see "ADD a new base" page 9 for an explanation), the fuel name (see Appendix B for a list of fuel names), and the quantity of fuel to be input at the base.

Notes:
1. This module won't let you update a base that doesn't already exist in the database. You must add first, then update.
2. Ensure you type the fuel name exactly like it is listed in Appendix B. Otherwise the program will not recognize it as a valid fuel.
3. Ensure you type in all entries left-justified. The program will not take your input otherwise.
4. You must run option 2 off the Main Menu, "Update base taskings for calculations" prior to running reports. See page 13 for information on this part of the program.

SUB sub Option 2: Update Fuels consumption rates.

To change fuel consumption rates (or expenditure rates) select option 2. The first input screen will ask for the fuel name (see Appendix B for a list of aircraft names), and the mission role to be flown (see Appendix A for a list of roles), and the associated consumption rate. This rate comes directly out of exercise OPORDs or war plans.

Notes:
1. This module won't let you update an aircraft that doesn't already exist in the database. Ensure you type the aircraft name exactly like it is listed in Appendix A. Otherwise the program will not recognize it as a valid aircraft.
2. Ensure you type in all entries left-justified. The program will not take your input otherwise.
3. Type the fuel name exactly like it is listed in Appendix B. Otherwise the program will not recognize it as a valid fuel.
4. This module won't let you input a role that isn't appropriate to an aircraft. Ensure you type the role or mission name exactly as it appears in Appendix A.
5. This module won't let you input an aircraft/role//fuel combination that isn't valid. Ensure that you use only valid combinations.
6. You must run option 2 off the Main Menu, "Update base taskings for calculations" prior to running reports. See page 13 for information on this part of the program.

SUB Option 3: Update Munitions Information.

If you choose update munitions information, select SUB Option 2 off the Update menu (see page 11). You will see this screen:

UPDATE MUNITION INFORMATION

1. UPDATE on station Munition LEVELS
2. UPDATE Munition EXPENDITURE RATES
3. ADD Munition TYPE to base master record
4. DELETE Munition TYPE from base master record
5. RETURN TO PREVIOUS MENU
6. QUIT

From this menu you have the option to update on station munition(s) levels and update munition consumption rates.

SUB sub Option 1: Update on station munition levels.

To change the amount of a munition at a base, select option 1. The first input screen will ask for the BASE IDENTIFICATION CODE (see "ADD a new base" page 9 for an explanation), the munition name (see Appendix C for a list of munition names), and the quantity of munition to be input at the base.

Notes:
1. This module won't let you update a base that doesn't already exist in the database. You must add first, then update.
2. Ensure you type the munition name exactly like it is listed in Appendix C. Otherwise the program will not recognize it as a valid munition.
3. Ensure you type in all entries left-justified. The program will not take your input otherwise.
4. You must run option 2 off the Main Menu, "Update base taskings for calculations" prior to running reports. See

page 13 for information on this part of the program.

SUB sub Option 2: Update Munitions consumption rates.

To change munition consumption rates (or expenditure rates) select 2. The first input screen will ask for the munition name (see Appendix C for a list of aircraft names), and the mission role to be flown (see Appendix A for a list of roles), and the associated consumption rate. This rate comes directly out of exercise OPORDs or war plans.

Notes:
1. This module won't let you update an aircraft that doesn't already exist in the database. Ensure you type the aircraft name exactly like it is listed in Appendix A. Otherwise the program will not recognize it as a valid aircraft.
2. Ensure you type in all entries left-justified. The program will not take your input otherwise.
3. Type the munition name exactly like it is listed in Appendix C. Otherwise the program will not recognize it as a valid munition.
4. This module won't let you input a role that isn't appropriate to an aircraft. Ensure you type the role or mission name exactly as it appears in Appendix A.
5. This module won't let you input an aircraft/role/munition combination that isn't valid. Ensure that you use only valid combinations.
6. You must run option 2 off the Main Menu, "Update base taskings for calculations" prior to running reports. See page 13 for information on this part of the program.

Option 3: Delete Aircraft Types, Fuel Types, or Munition Types.

Should you wish to delete an aircraft, fuel, or munition type from a new or existing base, select option 3 from the Update menu (shown on page 9). After selecting, you will see this menu:

```
                    DELETE FROM BASE MASTER RECORD



        1.  DELETE Aircraft TYPES

        2.  DELETE Fuel TYPES

        3.  DELETE Munition TYPES

        4.  RETURN TO PREVIOUS MENU

        5.  QUIT
```

From this menu you have the option to delete an aircraft, fuel, or munition type from a new or existing base.

To delete a fuel, munition or aircraft select 1, and then select the desired number (1 for Aircraft, 2 for Fuel, or 3 for Munition) at the next menu. The first input screen will ask for the BASE IDENTIFICATION CODE (see "ADD a new base" page 9 for an explanation), the aircraft/fuel/munition information(see Appendices A,B, and C respectively for a listing of types), and the quantity of the item to be input at the base.

Notes:
1. This module won't let you update or delete from a base that doesn't already exist in the database. You must add first, then update or delete.
2. Ensure you type the aircraft/fuel/munition name exactly like it is listed in the Appendices. Otherwise the program will not recognize the input as valid.
3. Type in all entries left-justified. The program will not take your input otherwise.
4. You must run option 2 off the Main Menu, "Update base taskings for calculations" prior to running reports. See page 13 for information on this part of the program.

3. DELETE a base:

To delete an entire base and its database, you must go to the Change menu (see page 8) and select option 3. At the first input screen you must input the BASE IDENTIFICATION CODE assigned to the base being input. This code is with the WRM BASE IDENTIFICATION CODE, or the identification code assigned by the exercise OPORD for the purposes of the exercise.

At the BASE NAME, input the name of the base as appearing on all reports. The name can not exceed 25 letters.

Notes:

1. The program will not allow you to delete a base not in the database, and will tell you if you attempt to do so.
2. Ensure you type in all input left-justified. The program won't correctly accept your input if you don't.
3. The program does not allow you to change your mind after deleting a base. Once you have deleted a base, it is erased from the database permanently.

## GENERATING REPORTS

To generate reports, return to the main menu:

```
                         MAIN MENU



         1.  ADD/UPDATE/DELETE base master record(s)

         2.  UPDATE base taskings for calculations

         3.  CALCULATE Days of Supply Reports

         4.  QUIT
```

To generate reports select option 3 off the main menu. At the following screen you must select your printer:

```
                        PRINTER



      1. ALPS P2000G/2000/EPSON Compatable/MPI
      2. DIABLO 620 or 630
      3. NEC Pinwriter P5/6/7
      4. Okidata Microline 84/92/93
      5. IBM Proprinter
      6. Citizen MSP-10/15
      7. HP LaserJet 500/+/II or TI 2115 Laser Printer
```

Following printer se lection, you have the option of calculating a fuel, munition, or base days of supply.

This is your selection menu:

```
                    CALCULATE DAYS OF SUPPLY



          1.  Calculate FUEL Days of Supply

          2.  Calculate MUNITIONS Days of Supply

          3.  Calculate BASE Days of Supply

          4.  RETURN to MAIN MENU

          5.  QUIT
```

The reports are printed automatically, therefore ensure the printer has paper and is turned on prior to selecting this option. Also note that you must update base taskings for calculations prior to printing reports.

**Option 1: Calculate Fuel Days of Supply.**

To generate a fuel DOS for a base, select option 1 off the menu. At the first input screen you must input the BASE IDENTIFICATION CODE assigned to the base being input. This code is with the WRM BASE IDENTIFICATION CODE, or the identification code assigned by the exercise OPORD for the purposes of the exercise.

At the BASE NAME, input the name of the base as appearing on all reports. The name can not exceed 25 letters.

Notes:
1. The program will not allow you to generate a report for a base not in the database, and will tell you if you attempt to do so.
2. Ensure you type in all input left-justified. The program won't correctly accept your input if you don't.

**Option 2: Calculate Munition Days of Supply.**

To generate a munition DOS for a base, select option 2 from the menu. At the first input screen you must input the BASE IDENTIFICATION CODE assigned to the base being

input. This code is with the WRM BASE IDENTIFICATION CODE, or the identification code assigned by the exercise OPORD for the purposes of the exercise.

At the BASE NAME, input the name of the base as appearing on all reports. The name can not exceed 25 letters.

Notes:

1. The program will not allow you to generate a report for a base not in the database, and will tell you if you attempt to do so.

2. Ensure you type in all input left-justified. The program won't correctly accept your input if you don't.

**Option 3: Calculate Base Days of Supply.**

To generate an overall base DOS, select option 3 from the menu. At the first input screen you must input the BASE IDENTIFICATION CODE assigned to the base being input. This code is with the WRM BASE IDENTIFICATION CODE, or the identification code assigned by the exercise OPORD for the purposes of the exercise.

At the BASE NAME, input the name of the base as appearing on all reports. The name can not exceed 25 letters.

Notes:

1. The program will not allow you to generate a report for a base not in the database, and will tell you if you attempt to do so.

2. Ensure you type in all input left-justified. The program won't correctly accept your input if you don't.

## WARNINGS

Keep your CLASSIFIED straight!

- This program is FOR OFFICIAL USE ONLY
- Once the user inputs either exercise or real world data, the program takes on the highest classification of input data.
- Should the program be used for other than test purposes, the program must be loaded on a **Tempest approved** computer system.
- Any data downloaded from the system must be marked and safeguarded, appropriate to the level of security classification.
- If you have any questions, contact your security monitor.

To avoid loss of data:

- DO NOT disconnect or turn off computer or printer during operation. If you expect a power-outage, log out of the program.
- DO NOT make any changes to the database except through this program. A change in the database will affect the accuracy of the Days of Supply calculations and may result in a failure of the program altogether.
- DO NOT add any files to the LOGDOS directory.

In case of loss of data through accidental power-outage:

- Delete the base records that suffered the damage through use of the delete base option.
- Input the base database again.

## NOTES/CONVENTIONS

KEYBOARD SPECIFICS:

| | |
|---|---|
| CAPITALS | This program is not "CAPS" sensitive. You may input either capital letters or lower case. |
| COMMANDS | User input is identified by boxes and the cursor automatically goes to them. |
| COLOR CODES PROGRAM TREE. | The menus are color coded to help the user to locate where she/he is on the LOGDOS |
| < > | The brackets indicate a key on the keyboard, such as <Y> for the "Y" key. |
| FUNCTION KEYS | This program does not use the function keys. DO NOT use the function keys, as use may result in loss of data. |
| NUMBERS vs. LETTERS | Do not substitute letters for numbers, the program will read an l as letter, and a 1 as the number. |
| BOLDFACE | In the User's Guide, **BOLDFACE** is used to signify the actual text or lines to be input in the computer. |
| PgDn | The page down key will allow the user to skip through entries on an input screen. |

## TRADEMARKS

| | |
|---|---|
| Clipper | NANTUCKET |
| dBASE III PLUS | ASHTON-TATE |
| IBM CORPORATION | INTERNATIONAL BUSINESS MACHINES |
| R&R Relational Report Writer | CONCENTRIC DATA SYSTEMS, INC |

## GLOSSARY

ATO  Air Tasking Order

DOS. Days of Supply (DOS) is a logistics, warfighting, capability measurement based on the type/number of aircraft flown, associated sortie rates, and consumption rate (for all consumables)--at a given time--based on projected roles and sorties.

CONSUMABLE. Items consumed in performance of the flying mission, such as fuel, munitions, film, and liquid oxygen.

CONSUMPTION RATE. The consumption rate is measured in sorties or by flying hour and indicates the amount of consumable used.

MODEL. A model is a set of rules or assumptions about a designated scenario and how these rules/assumptions are linked within the scenario.

ROLE. The role is the type of mission and aircraft flies.

SIMULATION MODEL. A set of assumption concerning a system assembled to imitate or represent real-world processes or complex systems or time.

SORTIE. A sortie is one take-off, mission, and landing of an aircraft.

SORTIE RATE. A sortie rate is aircraft specific, with rate established for all types of aircraft, depending on mission use. For example, a fighter aircraft's sortie rate is established at 3.4. At a 3.4 sortie rate, the fighter flies 3.4 times per flying day.

UNCERTAINTY. Uncertainty in models comes from three sources. irst, there is structural uncertainty about the scenario and the model. Second, estimation uncertainty exists when the model and scenario parameters are not known. Lastly, prediction uncertainty exists whether one knows model parameters or not (12:1).

WMP. The War Mobilization Plan and is published in five volumes to fufill the USAF requirement for a plan to support the Joint Strategic Capabilities Plan (JSCP) and Department of Defense mobilization and planning directives.

WMP 5. Contains the Basic Planning Factors and Data, sortie and flying hour data, used in planning requirement. WMP 5 contains the approved HQ USAF position on sortie rate/durations/attrition rates and flying hour requirements to support USAF Progammed and Mobilization force levels.

# APPENDIX A

| AIRCRAFT TYPE: | ROLE (MISSION): |
|---|---|
| A10 | CLOSE AIR SUPP |
| A7 | CLOSE AIR SUPP |
| A7 | INTERDICTION(BA |
| AC130A | SPEC OPS GUNSHP |
| AC130H | SPEC OPS GUNSHP |
| AC130U | SPEC OPS GUNSHP |
| B52 | STRATEGIC BOMB |
| C12 | OPS SUPP AIR |
| C130 | AERO EVAC |
| C130 | TAC AIR |
| C141 | STRATEGIC AIR |
| C141 | TAC AIR |
| C21 | OPS SUPP AIR |
| C5 | STRATEGIC AIR |
| C5 | TAC R (LIMIT) |
| C9 | AERO EVAC |
| EF111 | ECM DEF SUPPRES |
| F111 | INTERDICTION(LR |
| F15ABCD | AIR SUPERIORITY |
| F15E | AIR SUPERIORITY |
| F15E | INTERDICTION(AW |
| F16 AIR | SUPERIORITY |
| F16 | AIR-TO-GROUND |
| F4 | AIR-TO-GROUND |
| HC130N | HELO AR |
| HC130N | RESCUE |
| HH1H | OPS SUPP AIR |
| KC10 | STRATEGIC AR |
| KC10 | TAC AIR |
| KC135 | STRATEGIC AR |
| MC130E | AR |
| MC130E | SPEC OPS TACTIC |
| MC130H | SPEC OPS TACTIC |
| MH53HJ | SPEC OPS(ALL WE |
| MH60 | COMBAT SR |
| OA10 | ESCORT |
| OA10 | FAC |
| OA10 | RECCE (VISUAL) |
| OA10 | SR |
| OA37 | FAC |
| RF4 | RECCE(ALL WEAT) |
| OA10 | COUNTER INTELL |
| F4 | AIR SUPERIORITY |
| CH3 | SPEC OPS AIR |

# APPENDIX B

FUEL TYPES:

AVGAS
JP4
JP5

APPENDIX C

MUNITION TYPE:

105MM
2.75 FF ROCKET
20MM
25MM
30MM
40MM
50CAL
7.62MM
A/A42A-1
AERO27A
AERO3
AERO7
AGM136A
AGM45
AGM65
AGM65D/G/M
AGM69A
AGM78C/D
AGM84
AGM86B
AGM88
AGW/I2K/84
AIM120
AIM120A
AIM7E
AIM7F
AIM7M
AIM9E
AIM9J
AIM9L
AIM9M
AIM9P
ALA-17
ANM-14
B28
B43
B57
B61
BBU-35
BBU-36
BDU12
BDU12
BDU16
BDU26
BDU32

MUNITION TYPE:

BDU33
BDU35
BDU38
BDU6
BDU8
BLU109B
BLU52
BRU3
CBU38
CBU52
CBU52H
CBU52L
CBU58
CBU58H
CBU58L
CBU71
CBU87
CBU89
CBU97/SFW
CBU98(DAACM)
CCU-43
CCU-44
DAACM
DURANDAL
GAU-8
GBU10
GBU12
GBU15
GBU15IR
GBU24
GPU-5/A
HAVE NAP
LAU-106
LAU-114
LAU-117
LAU-118
LAU-131
LAU-3
LAU-34
LAU-68
LAU-7
LAU-77
LAU-88
LAU-88
LAU-88
LAU-88
LAU-88

MUNITION TYPE:

LUU-1
LUU-2
LUU-2B
LUU-2E
M-1
M-117
M-117A
M-117R
M-117RA
M-129
M-129E2
M-156
M-18
M-206
M-229
M-36
M-8
M-61
MAU-111
MAU12
MAU40
MAU50
MER-3/9/10
MJU-10
MJU-10B
MJU-11A
MJU-12A
MJU-2/B
MJU-7B
MK-1
MK-1M2/3
MK-20
MK-25
MK-25M3
MK-2M1
MK-50
MK-6
MK-6M3
MK-82
MK-82/M-117
MK-82A
MK-82A/M-117A
MK-82R
MK-82R/A
MK-82R/M-117A
MK-82RE
MK-84

MUNITION TYPE:

MK-84A
MK-84R
MK-106
RR-112
RR-119
RR-136
RR-141
RR-149
RR-155
RR-156
RR-161
RR-162
RR-163
RR-167
RR-170
RR-177
RR-180
RR-72
RR-72B
RR-97
SUU-20
SUU-21
SUU-23
SUU-25
TER-3/9/9A/15
TH-650
TH3-200
WDU-4A/A

TEST AIR BASE

FUEL DAYS OF SUPPLY (DOS) REMAINING
BASED UPON 05/13/90
SORTIE RATES AND EXPENDITURE RATES

TEST AIR BASE HAS 1.852 DAYS OF SUPPLY REMAINING

WHICH AMOUNTS TO 100000 GALLONS
OR 2381 BARRELS

PER DAY FUEL USE BY TYPE OF AIRCRAFT/ROLE:

| AIRCRAFT/ROLE | PER DAY USE IN GALS |
|---|---|
| F16/AIR SUPERIORITY | 24000.000 |
| F16/AIR-TO-GROUND | 30000.000 |

TEST AIR BASE

MUNITION DAYS OF SUPPLY REMAINING
BASED UPON 05/13/90
SORTIE AND EXPENDITURE RATES

TEST AIR BASE HAS 0.151 DAYS OF SUPPLY REMAINING

PROJECTED MUNITION EXPENDITURES PER DAY ACROSS AIRCRAFT TYPES:

| MUNITION: | PER DAY CONSUMPTION: | LIMITING MUNITION? |
|---|---|---|
| AIM7M | 198.400 | YES |
| 20MM | 109.600 | NO |
| MK-84 | 120.000 | NO |

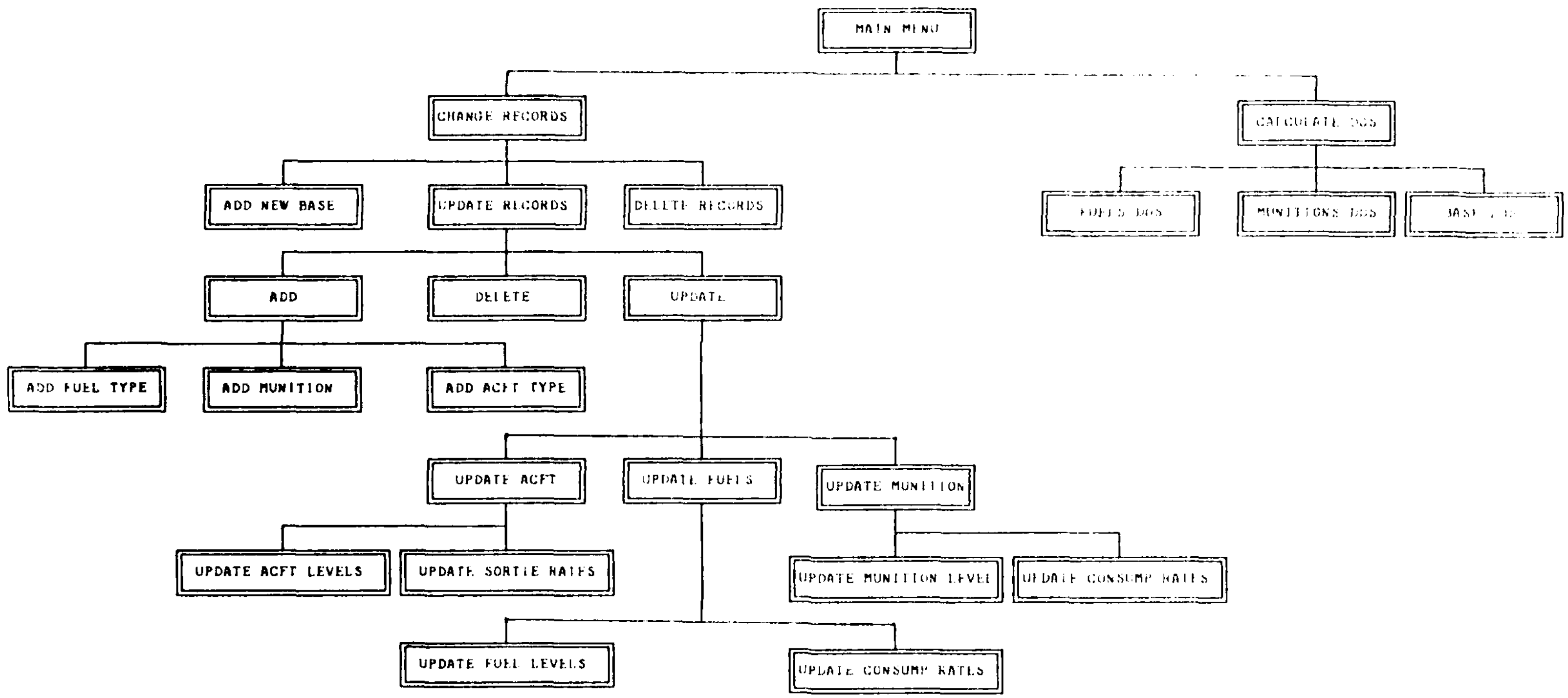
TEST AIR BASE

DAYS OF SUPPLY (DOS) REMAINING
BASED UPON 05/13/90
SORTIE AND EXPENDITURE RATES

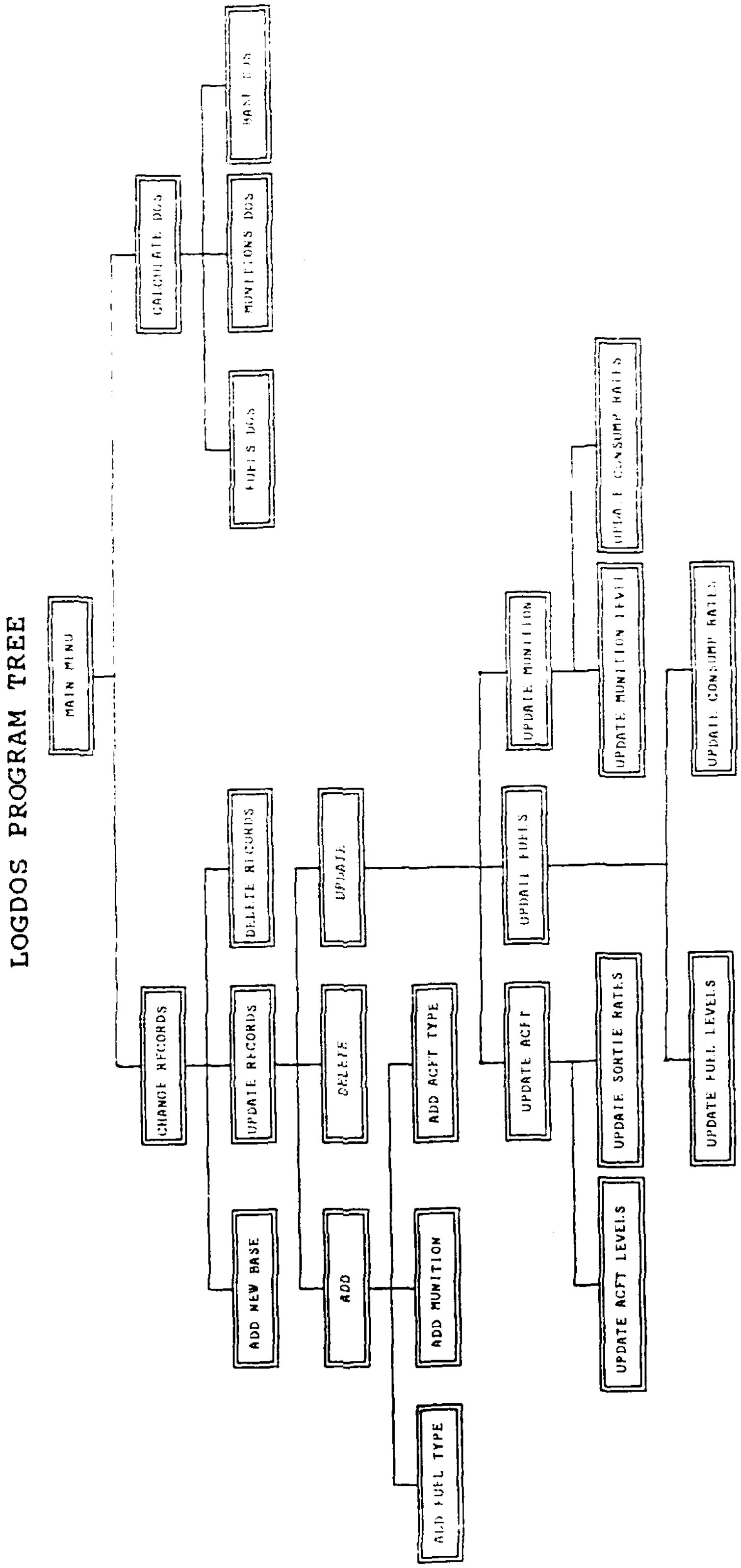
TEST AIR BASE LIMITING FACTOR IS MUNITIONS

| FUEL DAYS OF SUPPLY ARE: | MUNITIONS DAYS OF SUPPLY ARE: |
|---|---|
| 1.852 | 0.151 |

LOGDOS PROGRAM TREE



<u>Appendix F: LOGDOS Program Tree</u>



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# Vita

Captain Cheryl A. Duckett [redacted] graduated from Travelers Rest High School of Travelers Rest, South Carolina in 1974 and joined the United States Air Force following graduation. Trained as an Aircraft Mechanic, her assignments included a tour in Guam and a tour at Castle AFB, California. After discharge, she attended Gavilan College, California, where she received her Associates of Arts in Business. She continued her studies at the University of Santa Clara, California (major: Marketing), and received a Bachelor of Science in Commerce in June 1984. Commissioned through Officers' Training School, she attended technical school and was awarded a Logistic Officer AFSC in 1985. Her first assignment was Assistant Chief of Resource Plans at the 4TFW on Seymour Johnson AFB, North Carolina. She was then assigned as Chief of Logistic Plans at TUSLOG, in Ankara AS, Turkey. There she was responsible for all logistic planning support of HQ TUSLOG, three main support bases, four munitions support squadrons, and 16 collocated operating bases until entering the School of Systems and Logistics, Air Force Institute of Technology, in May of 1989.

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**13. ABSTRACT** *(Maximum 200 words)* The purpose of this thesis was to develop a model depicting a "days of supply" (DOS) and implement it through a computer program (LOGDOS) meaningful to both operations and logistics personnel for command post exercises or wartime use. LOGDOS was specifically designed for Air Force units having a flying mission. However, the model could be utilized in other units, after identifying a meaningful "measure of merit." Following a literature review, a model was developed and implemented using dBASE III+™, R&R Report Writer™, and Clipper™. The developed program, LOGDOS, was then pre-tested, tested, and validated. The program meets sponsors needs and includes many improvements suggested by the sponsor unit during program testing/validation. LOGDOS is easy to install, easy to use, and does not require user knowledge of any of the software development tools (such as dBASE III+™ or Clipper™). LOGDOS operates on a IBM-compatible micro-computer with 640K RAM, one hard drive disk drive, one 5.25 floppy disk drive, a monitor (monochrome or color), and an 80-column printer capable of continuous form paper.

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